the OIL AND GAS JOURNAL

JUNE 30, 1958

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Seeligson Recovery Project Started

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Two Multiple Completions Are Firsts

- CATC uses four strings in quadruple completion
- Texans encouraged by triple-completion precedent

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Unusual Airline Serves Four Corners

It operates only two planes, and is off bounds to company brass.

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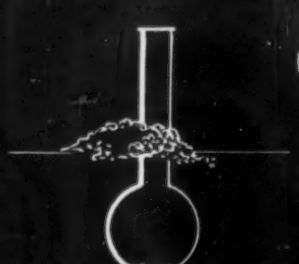
Beginning: Five-part series on

Geochemistry

Will it produce a powerful new tool for the explorationist? p.126



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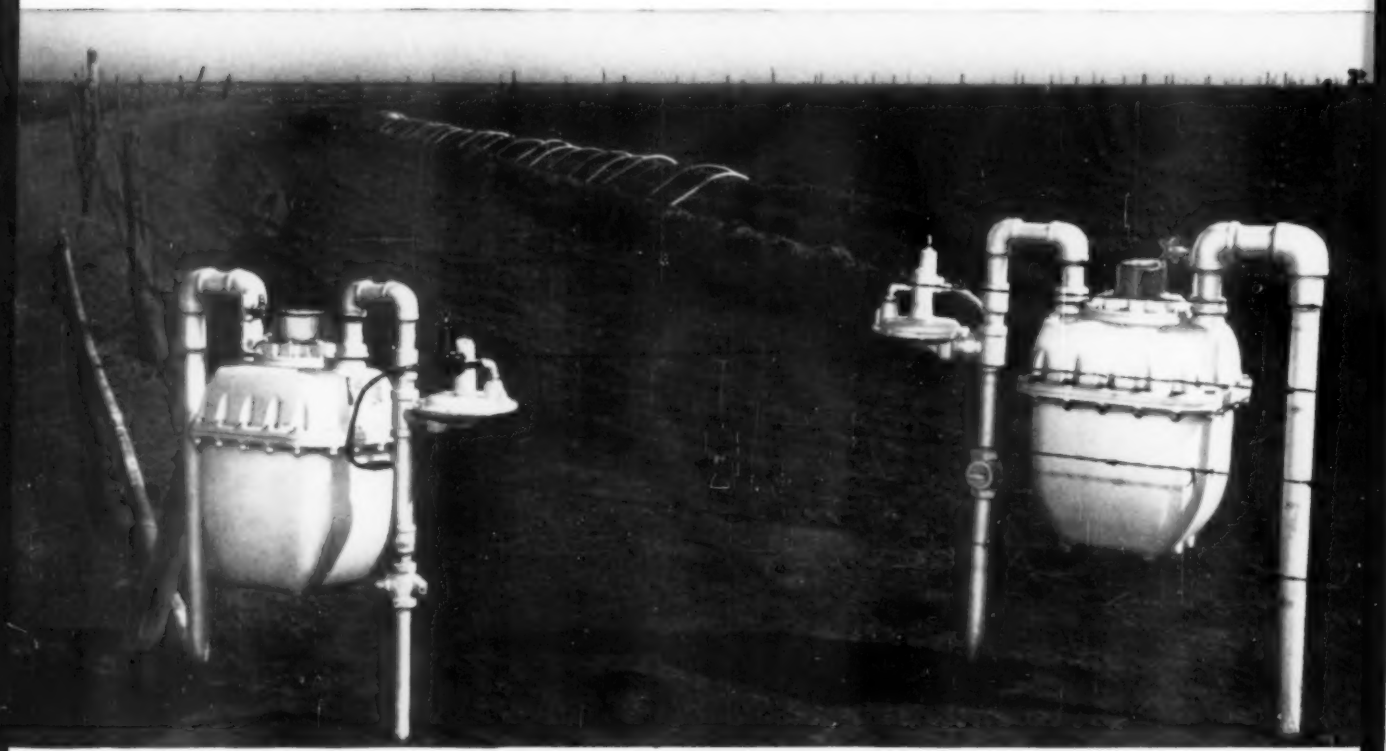

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This Rockwell "5000" aluminum meter with Emcorector is the master meter for five irrigation wells, submetered by five Rockwell "1600" meters.

the OIL AND GAS JOURNAL Newsletter

Tulsa, Okla.
June 30, 1958

Two milestones reached in oil production:

The world's first quadruple completion using four tubing strings has been completed in the Gulf of Mexico (p. 48), and the Texas Railroad Commission gave its precedent-setting approval of a triple oil completion (p. 48).

CATC offshore group's history-making well flows oil from four separate sands through four separate tubing strings. It is 10 miles off Louisiana's Southwest Pass.

There have been other quadruple completions, but they used three tubing strings, with the casing annulus serving one producing zone.

A fourth tubing string was needed for the CATC well because the casing annulus was filled with mud for protection against hurricanes or ship collisions.

It was a pleasant surprise for producers when the commission switched its policy and approved completion of a Fasken field well in three separate oil reservoirs.

A few months ago, the commission was declining to even accept for hearing applications for triple oil completions.

The action undoubtedly will lead to a rash of new applications and refiling of old ones which were turned down in the past.

Texans—who like to do things in a big way—now can boast of one of the largest, most complex pressure-maintenance projects yet (p. 41).

It's the unit operation of 14,240 acres of the Lone Star state's mammoth Seeligson field.

It took 10 years of engineering before the pressure-maintenance project was started.

Full development is scheduled within a year. Here's what the unit operator, Sun Oil, expects the project to do:

...Boost liquids recovery by more than 60 million barrels.

...Increase income to producers and royalty owners by almost $200 million.

Light planes, operating on an airline schedule, are cutting costs, speeding men to their jobs in the formidable Four Corners country.

Four Corners Pipeline set up the unusual airline by leasing the entire service, finds it is solving its transportation problems in the rugged area (p. 52).

Canada's oil and gas industries had little to cheer about in the Progressive Conservative Government's first budget.

The budget proposes two minor oil tax amendments. But there was no mention of what the Canadian Petroleum Association wanted to hear—a long-sought increase in depletion allowance.

The two proposed amendments, if approved by parliament, would:

...Permit oil companies to deduct from taxable income bonus payments made to governments for exploration reservations. That's providing the land was surrendered without commercial production being found.

...Expand deductible drilling expenses to include cost of wells drilled for salt water disposal systems, reservoir pressure-maintenance systems, or other secondary recovery systems for oil or gas.

Oil industry members say the amendments will be some help. But a real shot in the arm would be to give producers the same depletion allowed royalty owners for a quarter of a century—a deduction of 25% of gross proceeds from oil and gas production.

Oil men haven't thrown in the towel.

They're clinging to one last hope—that the finance minister in his budget speech dealt only with income tax changes requiring parliamentary approval. The depletion allowance could be changed without such approval.

Newest member of the Federal Power Commission is an independent thinker and an outspoken individual. He's John Hussey, who was sworn in last week to succeed Digby.

He may prove a refreshing addition to bureaucratic Washington, though his friends say his frankness may be too much for a successful political figure. For one thing, he's against giving the FPC more authority (p. 54).

A new twist in oil-industry public relations has been tried successfully in Houston. Thirty school teachers took a 3-week short course on oil, got 3 hours' credit from Houston University.

The idea: Explain oil to the teachers as the best way of explaining it to tomorrow's citizen public (p. 56).

Deep wells going deeper:

World's deepest hole, Phillips' 1-EE University in Pecos County, Texas, was past 23,500 ft. last week, making

45 to 50 ft. a day. It still hasn't hit the base Ellenburger.

Oklahoma's depth record-holder, Shell's 5 Rumberger in Elk City field, passed 21,000 ft. It is making 48 ft. a day.

A slim, new gun perforator has been developed by Schlumberger.

It will slip through 1½-in. tubing for perforating casing below tubing. New design eliminates bulky primacord, uses primer tubes to provide chain firing. Purpose is to meet demand for a gun with no moving parts for use in multiple completions (p. 58).

Humble is stacking many of its offshore rigs. Once the biggest operator offshore, it has pulled in its horns in the gulf until economics improve.

At one time Humble had 21 rigs working in the gulf. Now it is down to only two. The cutback has been gradual for many months. The rigs will be kept in mothballs until offshore drilling looks brighter (p. 44).

Western Oklahoma is grabbing headlines with three remote wildcats—two of them candidates for "discovery of the year."

All are "firsts" in one way or the other:

...Sinclair's 1 Holcomb in Harper County—first Arbuckle producer in western Oklahoma.

...Magnolia's 1 Miller—first field in Custer County.

...Jackson's 1 Haigler—first field in Blaine County.

Sinclair's discovery found six potential pay zones, opens the Arbuckle-Ordovician formation to extensive future exploration.

Jackson's 1 Haigler jumped Oklahoma's Woodward Morrow-Pennsylvanian trend nearly 50 miles. Nearest oil production is 20 miles northeast at Ringwood, while nearest Morrow production is far to the northwest at Southeast Woodward gas-distillate field.

Magnolia's 1 Miller has had commercial flows of gas and condensate on a drill-stem test of the Springer-Pennsylvanian sand. If completed as a successful well, Oklahoma will have a new productive county (p. 125).

The summer exploratory trend in the Rockies seems to be deep drilling.

Promising a period of interesting and far-reaching wildcatting in the mountain states is this picture:

...Seven wildcats on their way to the Mississippian in Utah.

...Dakota success and subsequent development drilling rising in the San Juan basin.

...Carter's proposed remote wildcat on the basin's west flank in the Green River country. At 14,000 ft., it will be the deepest well on east side of Wyoming's "gas basin."

...Renewal of Permian exploration in the Denver basin, a Cretaceous giant. Brinkerhoff Drilling plans a Lyons well at Black Hollow, the basin's only big Permian field. And there are reports of two other tests planned in the basin.

Construction may start this summer on Katy and New York Central railroads' 2,500-mile LPG pipeline from Houston to New York City. It depends on when guaranteed throughput goal of 40,000 bbl. daily is realized.

Plans now call for a 10-in. line from Houston to Kansas City and a smaller diameter eastward through Wood River, Indianapolis, Cleveland, Buffalo, Albany, and New York City. There would be a 6 and 8-in. leg from the Texas Panhandle which would pick up product in southern Oklahoma en route to the main line near McAlester.

Target date for completing the $85-million line is November 1, 1959. The line offers a 5 to 6-cent a gallon tariff saving for eastern markets.

Freeport Sulphur is considering feasibility of transporting sulfur from its offshore Gulf of Mexico plant to Grand Isle through a 7-mile, heated pipeline under the gulf. Production from the offshore sulfur-mining operations is expected in 1960.

The pipeline construction picture has changed dramatically in recent weeks.

The Memphis decision, which posed financing problems for gas lines, delayed several projects until companies learned to adjust to it.

Now the big backlog of work has suddenly been released and pipeline companies and contractors have a new problem: completing the thousands of miles of construction before the winter heating season. Some of the projects scheduled for this year will have to slop over into 1959.

Jet fuel consumption by commercial airlines will reach 1 billion gallons per year by 1960, and 2½ billion in 1965.

That's what P. A. Lether, Northwest Airlines, told the North American gasoline tax conference last week.

These figures are dwarfed by military demands. Military is now using four times as much JP-4 as total commercial requirements will be 2 years from now.

Sun Oil has stopped shipping U. S. crude to its Sarnia, Ont., refinery. These exports, which averaged 16,100 bbl. daily in last half of 1957, and 7,460 bbl. daily in first 5 months of 1958, were not continued into June.

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OLIVER

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R. B. Hodgson & Company of Dallas used the Oliver OC-4 with narrow 31-inch tread to level the bottom of this 33-mile ditch at Midland, Texas. It reduced manpower requirements from a 7-man crew to one operator and two cleanup men.

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Here's another way the versatile OC-4 can cut costs on pipeline jobs. New 4-speed transmission provides a change of pace ranging from 1½ to 5¼ m.p.h. to meet every need for speed and power. It's available with a complete line of attachments for scores of assignments around rigs and refineries, too. Ask your Oliver distributor for all the facts. Or write us for literature.

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NEW YORK OFFICE
500 Fifth Avenue
Phone LOngacre 4-6160

Paul Swain ... International Editor
Ray G. Gibson ... District Editor
John P. O'Donnell ... District Editor

HOUSTON OFFICE
802 American Investors Building
Phone CApitol 4-7726

Larry Resen ... District Editor
Ed McGhee ... Drilling Editor
Joe Reilly ... District Editor

DALLAS OFFICE
1238 Mercantile Bank Bldg.
Phone Riverside 8-3074

Robert J. Enright ... District Editor

LOS ANGELES OFFICE
650 South Grand Avenue
Phone MAdison 2-0722

D. H. Stormont ... West Coast Editor
William T. Smith ... District Editor

WASHINGTON OFFICE
621 Albee Building
Phone District 7-1710

Bertram F. Linz ... District Editor

Correspondents at Denver, Pittsburgh, Calgary, Columbus, Ashland, Ky., Oil City, Pa., Mount Pleasant, Mich., Melbourne, Australia; Regina, Sask.; Chatham, Ont.; Casper, Wyo., and Anchorage, Alaska.

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TECHNOLOGY—OPERATION

Drilling-Production

The Spraberry Can Be Flooded **64**

By L. F. Elkins

Water-flooding tests in the Spraberry indicate that oil production can be significantly increased if flooding rates are sufficient to restore reservoir pressure. Unitization, then, is needed on a large-scale basis so that flooding work can proceed.

Drilling From a Floating Vessel **68**

By R. F. Bauer, A. J. Field, and Hal Stratton

Drilling into submerged lands from a floating vessel is now a reality. This new technique will have a profound influence on the future of offshore drilling. Its originators claim that it permits offshore drilling for onshore prices.

Field Processing—53: Calculation of Compressor Horsepower **94**

By John M. Campbell

These calculations may be carried out using ideal gas equations or enthalpy charts. The requirements can be calculated theoretically using established thermodynamic relationships.

Pipelining

Unsteady-State Flow of Natural Gas **86**

By J. M. Nelson and J. E. Powers

The University of Oklahoma has developed a program for computing these flow patterns using the basic IBM computer. Such questions as: (1) What happens when outlet pressure is suddenly decreased? (2) What is the storage potential of the line? (3) Rate of depletion of the gas from the pipelines, etc., can be answered.

On The Job . . . Pipelining: Meter Calibration **107**

By M. A. Levy

The effect of viscosity on meter factors in refined product service is an important factor in meter calibration. This is being done by setting up strict calibration procedures where pipeline meters are calibrated.

Refining-Processing

Gas Chromatography—Powerful New Tool for Chemical Analysis **73**

By H. H. Hausdorff and N. Brenner

Vapor chromatography is a relatively new type of instrumentation based on adsorption and partition principles. It provides excellent analytical results for gases and liquids with boiling points as high as 400° C.

Process-Stream Analyzers Serve Petrochemical Plant Well **76**

By D. M. Wreyford and Noyes Richey

Texas Butadiene & Chemical Corp. uses these analyzers to minimize a loss of valuable material in the butylene and butadiene recovery area. Isobutane to olefin ratio in the alkylation charge is monitored. Infrared, ultraviolet, and gas-chromatography techniques are represented.

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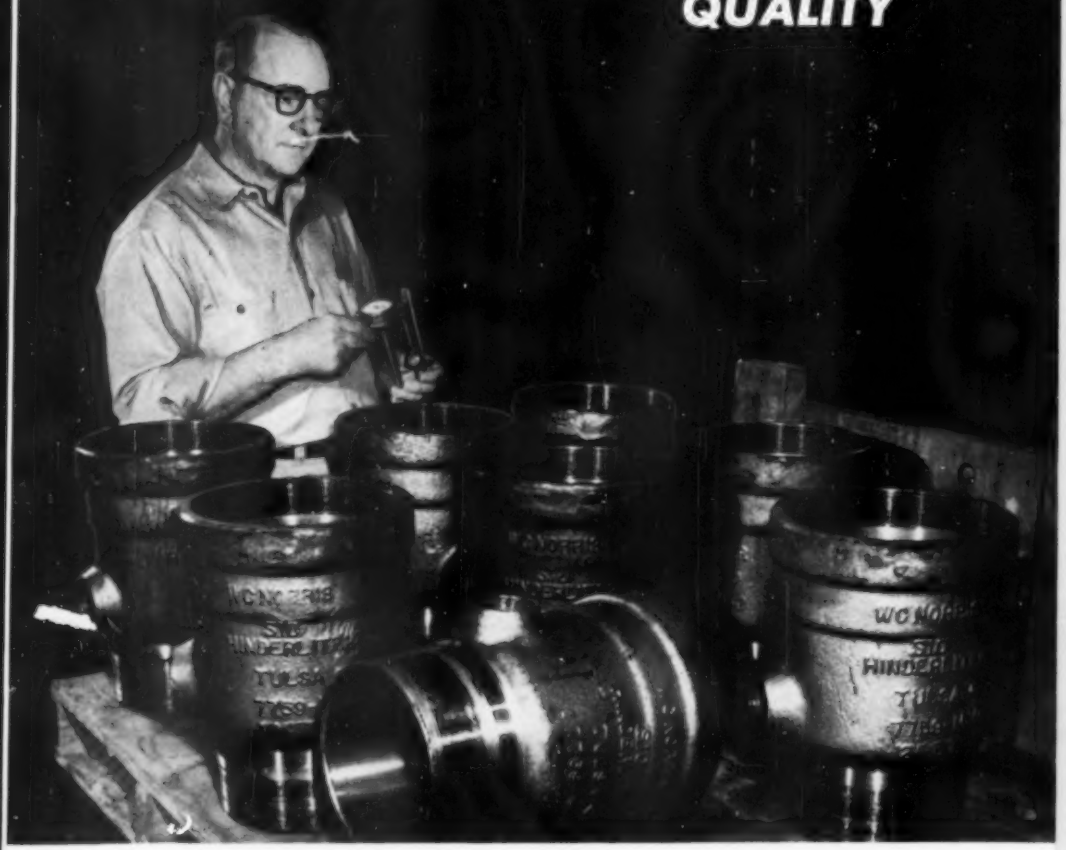

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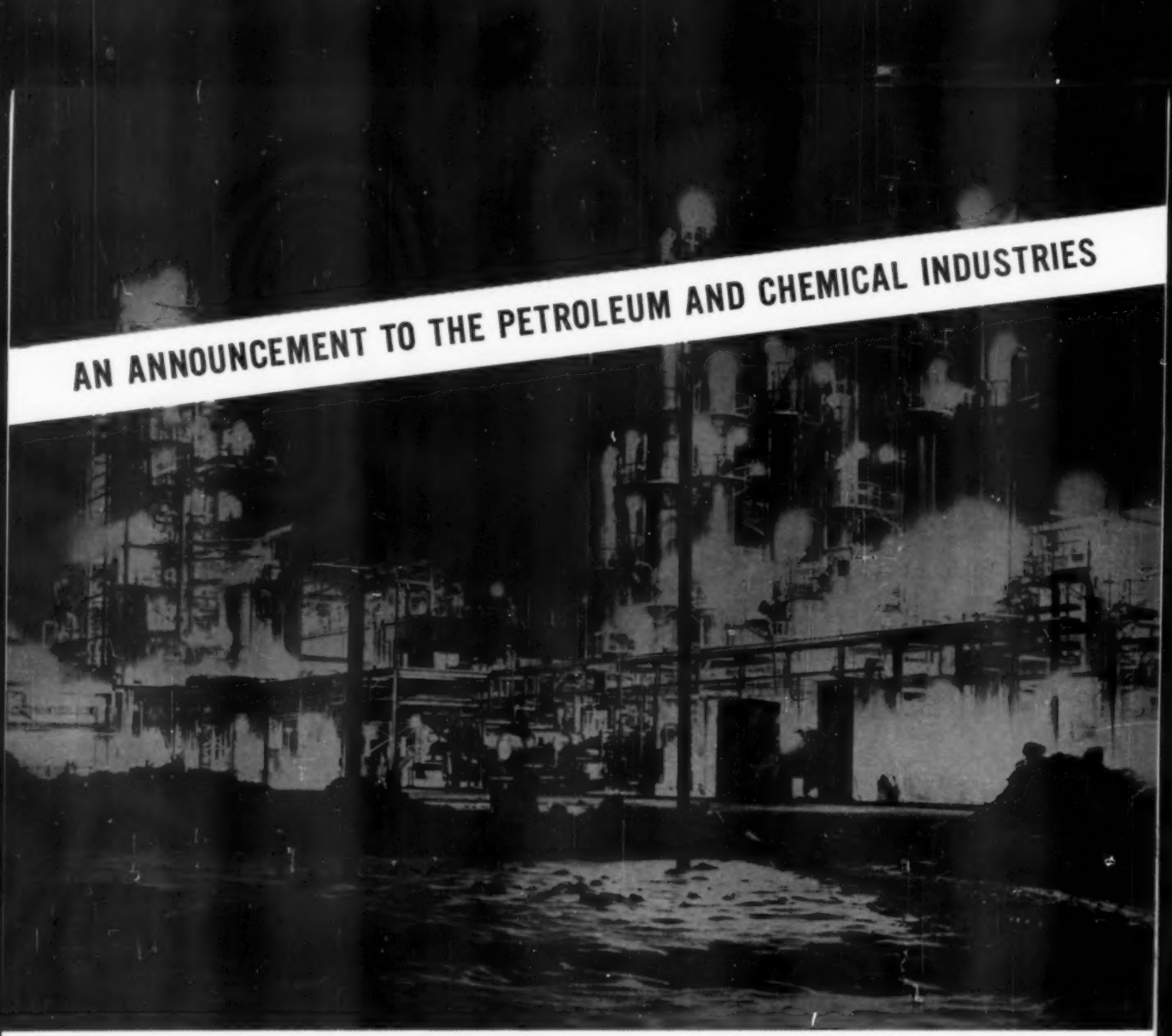

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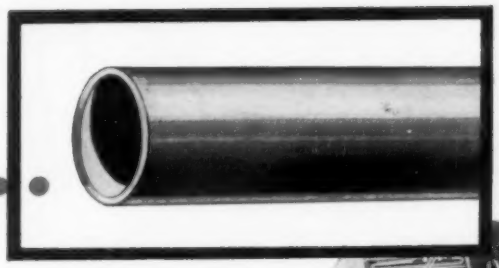

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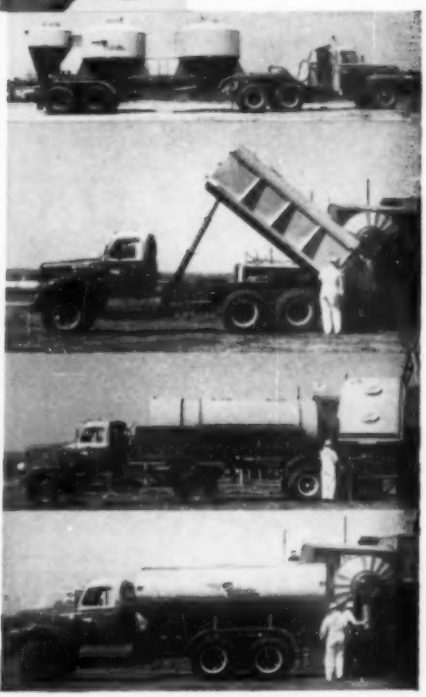
- Neat cement unused is returned to bulk plant for credit instead of being left on ground and lost.
- Industrial hazards are reduced.
- Cement is fully protected against weather while en route to well.



At Halliburton, bulk cementing is completely integrated, from bulk cement plant to mixer. To improve bulk cementing still further, Halliburton has developed a number of special cements and chemical additives to formulate cements to meet individual well requirements.

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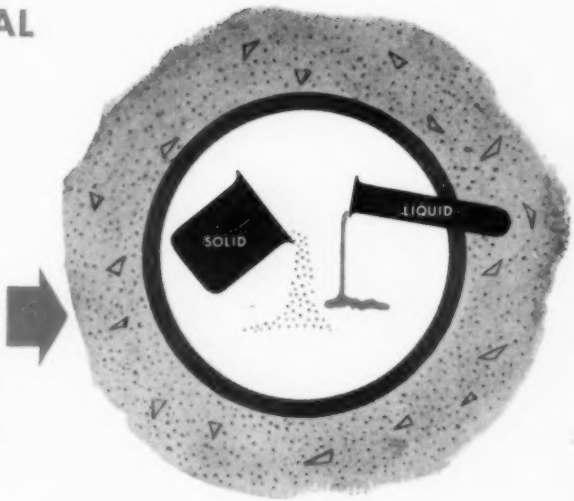

DIACEL CEMENT

Diacel cement is a low density composition. Diacel D, a light weight additive blend with portland cement, is used to increase the volume of mixing water, resulting in a lighter weight slurry and a greater yield. Where low fluid loss properties are desired, Diacel LWL can be used to give filtration rates comparable to drilling muds. This low water loss additive can be utilized with virtually all types of cementing composition; also functions as a retarder for deep well cementing.

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Newest scientific tools for use in locating cement tops, even in multi-stage jobs, determination of possible areas requiring remedial treatment, locating split pipe, are RAC-1 and RAC-2. Controlled half-life of material makes for safe, surer identification of cement, even after considerable delays following original job. No contamination to equipment or production. Also RAYFRAC Sand, for use fracture area determination.

SALT BRINE CEMENT

The dry blending of salt in cementing composition eliminates foaming and delay in dissolving salt in water before mixing with cement. A saturated Salt Brine Cement improves the bond to a salt formation and does not dissolve the salt as would occur with the circulation of fresh water slurries. In deep wells, Salt Brine Cement does not require retardation, as saturated salt brine will sufficiently retard cement to permit placement.

MUD-KIL

Mud-Kil is a dry, granular material that may be mixed in the dry cement or dispersed in the mixing water. It effectively neutralizes the cement-retarding properties of quebracho and other tannins, starch, sodium carboxymethyl cellulose and lignite. Pumping time and compressive strengths of cement are unaffected.

PERLITE

This expanded perlitic material has good bridging characteristics and reduces the weight of the slurry column. Addition of Perlite and 2%-6% bentonite to cement increases the amount of water required to mix a slurry of proper viscosity . . . increasing the slurry volume.

HOWCOGEL

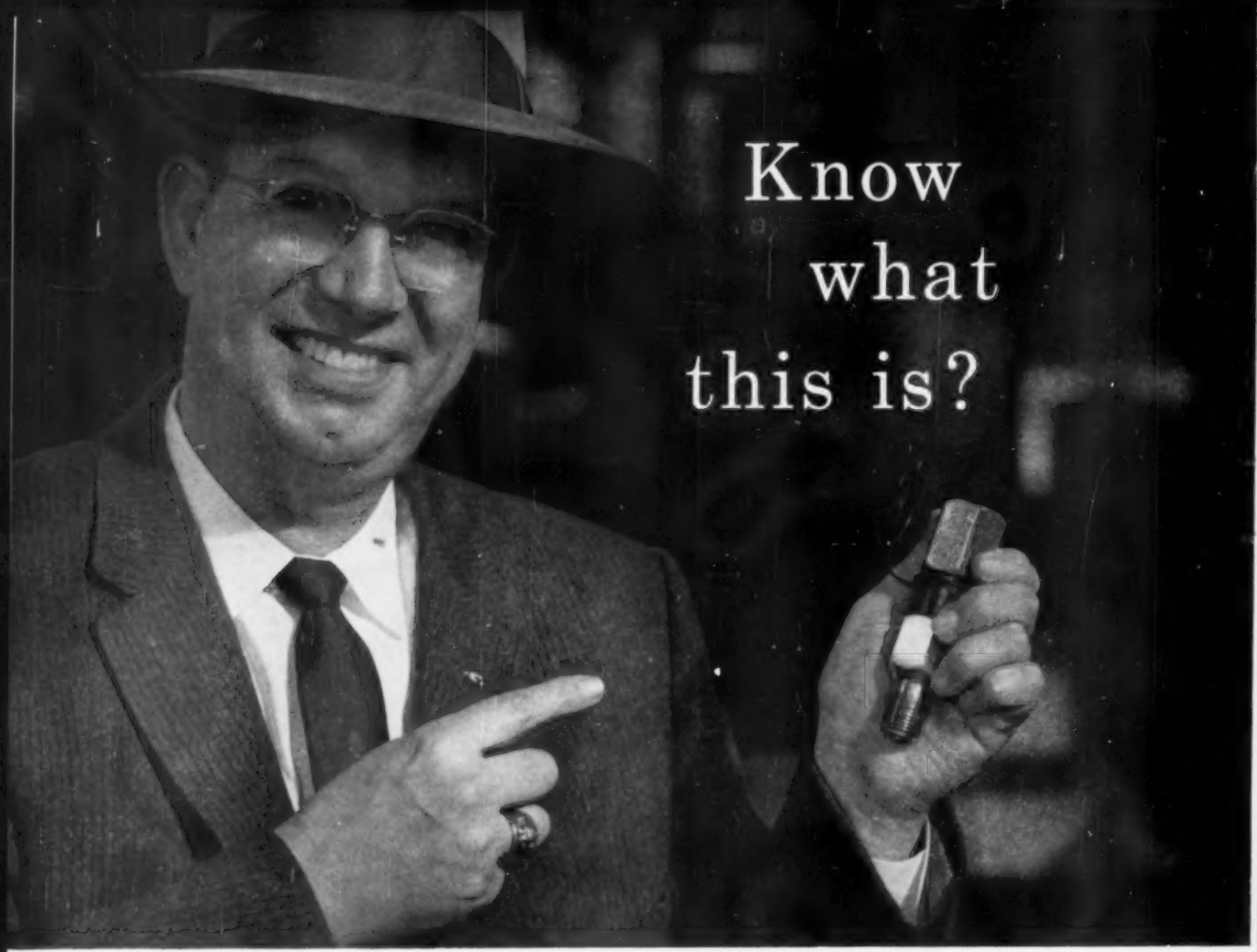
A high yield type bentonite used in cement to reduce slurry weight and increase slurry volume. Reduces slurry cost. When mixed with mud, Howcogel provides low fluid loss. It reduces filter cake thickness and has outstanding gel-strength properties.

LATEX CEMENT

A low fluid loss cement, with superior perforating properties, especially recommended for primary casing cementing . . . "tail-in" on primary cementing job . . . squeeze cementing . . . cementing liners.

CEMENTING SERVICES

284 SERVICE CENTERS — JUST MINUTES AWAY FROM YOUR WELL



It's a real slick little tool that can save you a lot of fixed capital investment - and bother - each year.

To obtain well pressure reading, insert master gauge with Connector in Gauge Valve and turn gauge 45 degrees. Gauge Valve opens automatically, exposing gauge to pressure. Remove gauge and Gauge Valve closes automatically.

HERE'S HOW IT WORKS: Instead of buying one or two pressure gauges for each Christmas tree, you buy just one master gauge *for an entire field.* Then, install these inexpensive Gauge Valves where you have been installing permanent type gauges—one on the tubing and one on the casing. Your Gauger takes the master gauge from well to well, stabs it into the Gauge Valve to obtain the pressure reading.

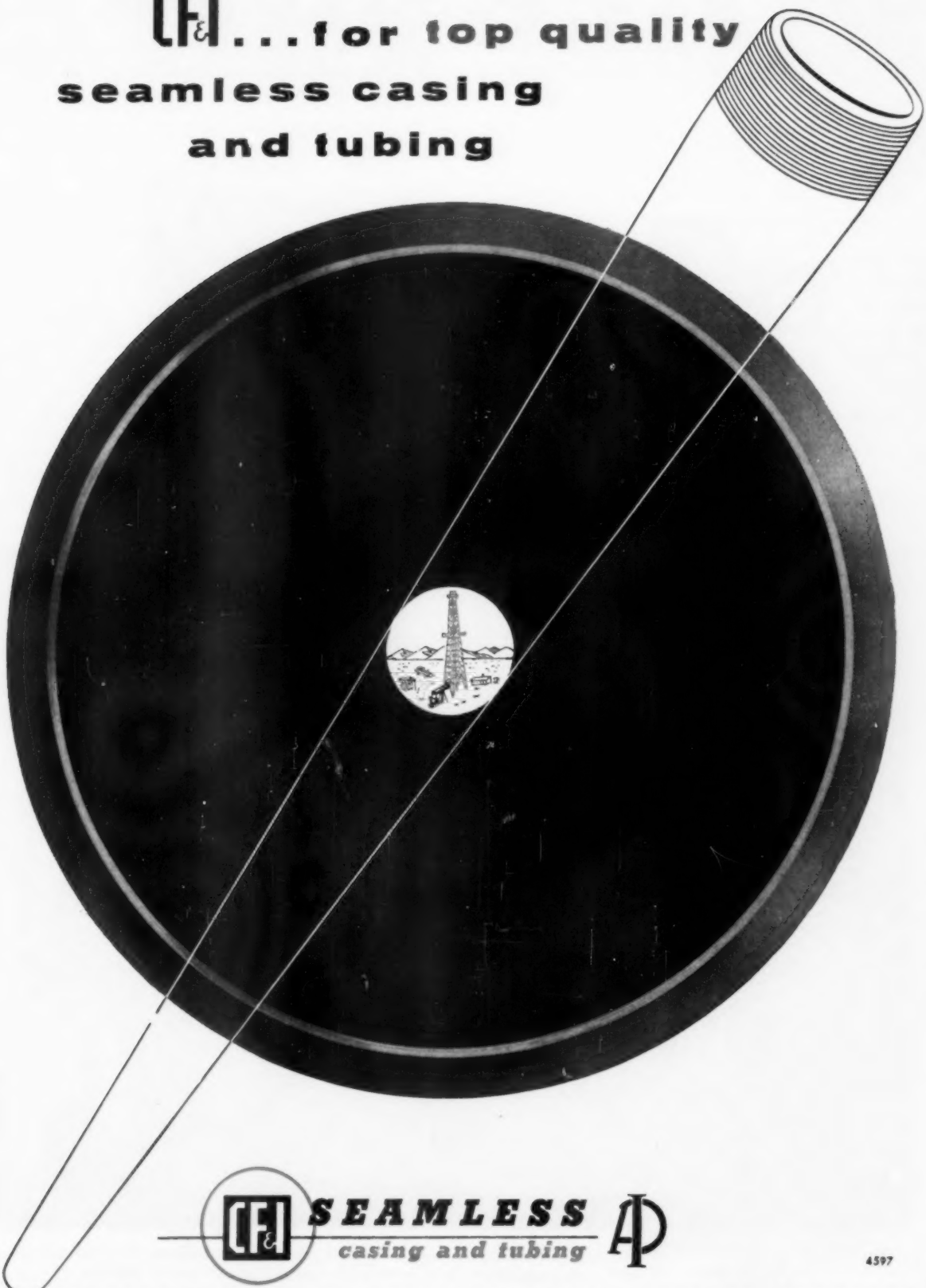
Only one gauge to buy.
No breakage.
No gauge repairs.
No exposure to elements.
No inaccurate pressure readings.

Ask any UNIBOLT man to demonstrate the Gauge Valve and Connector, or write:

THORNHILL UNIBOLT CRAVER CO.

P. O. BOX 1184 • HOUSTON, TEXAS

CF&I . . . for top quality seamless casing and tubing



CF&I SEAMLESS casing and tubing

4597

THE COLORADO FUEL AND IRON CORPORATION • DENVER, COLORADO

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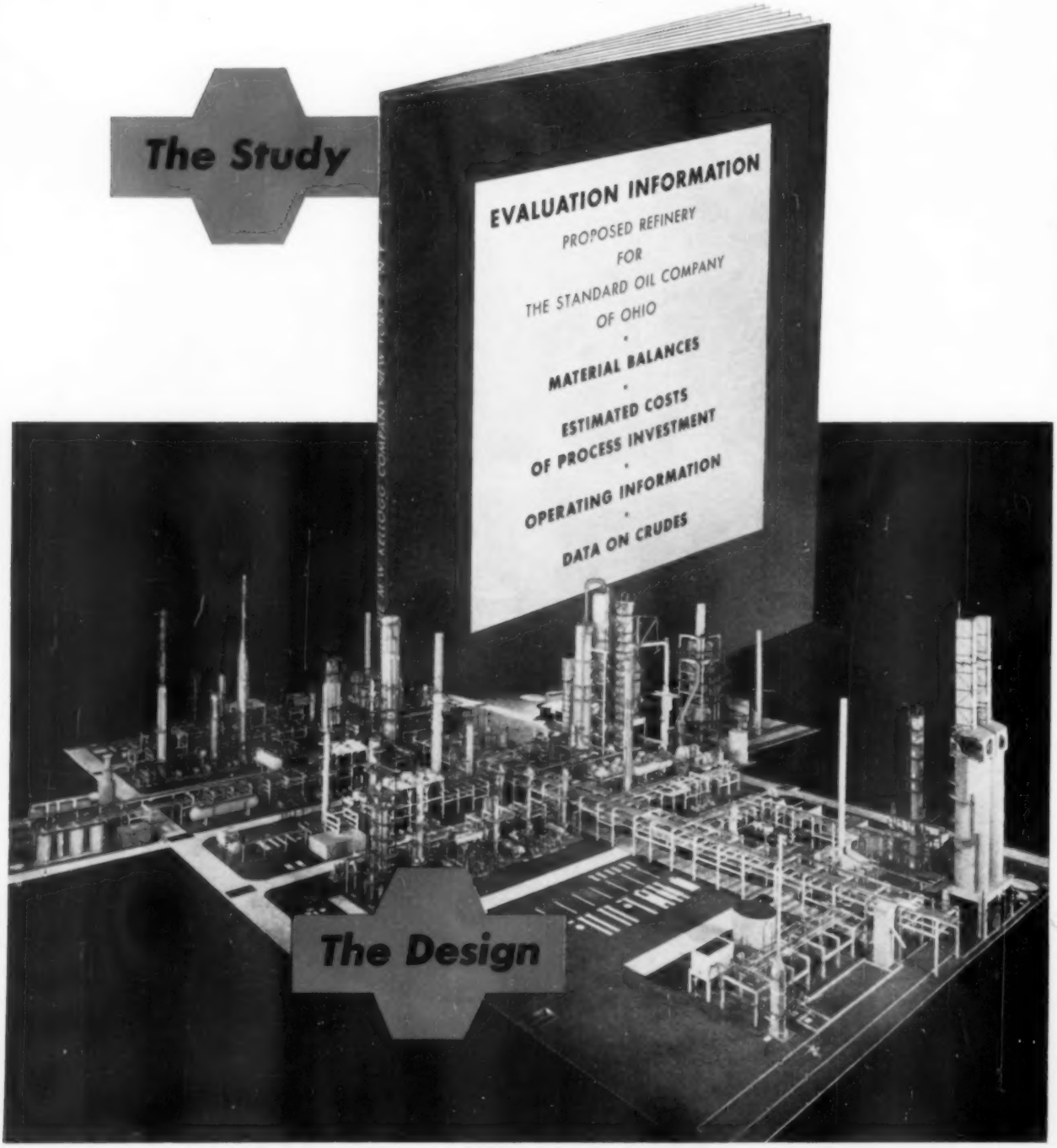

To achieve the ultimate in design, yet assure the most economic plant, Kellogg built this 26' x 29' scale model concurrently with designs to assist all levels of management, as well as all categories of engineering and refinery personnel, in design reviews well in advance of major construction.

Economic Achievement

When refining capacity must be increased, an oil company's planning group has to evaluate the technical and economic pros and cons of modernizing by degree or scrapping outmoded facilities and rebuilding completely. When the decision is to start from scratch, hundreds of variables are involved in choosing location, type and range of crudes, product mix, process line up, degree of integration, and refinery size. Which combination will insure the optimum in efficiency, economy, yields, flexibility for the future, and return on investment?

Faced with exactly this time-consuming multiplicity of problems, The Standard Oil Company of Ohio first scheduled decision deadlines for each planning phase, then called upon Kellogg for refinery material balances, estimated process investment costs, operating information, and data on various crudes. Decisions from this study, each made on schedule, served as the blueprint for Kellogg's second assignment—engineering and constructing an integrated new plant at Toledo, Ohio. Designed for a capacity of 60,000 BPSD, this $40 million refinery is an outstanding example of sound economics at work in plant planning and execution.

With most oil companies concerned with tomorrow, there is no better time to be discussing future plans and problems with Kellogg than today. Kellogg's Contract Sales Division welcomes the opportunity to put its coordinated engineering, procurement, and construction services at your disposal.

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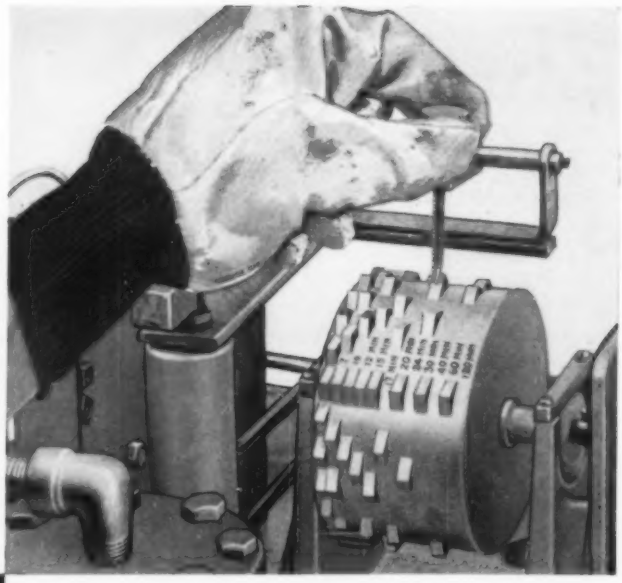
Kellogg Pan American Corp., New York • Societe Kellogg, Paris • Companhia
Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

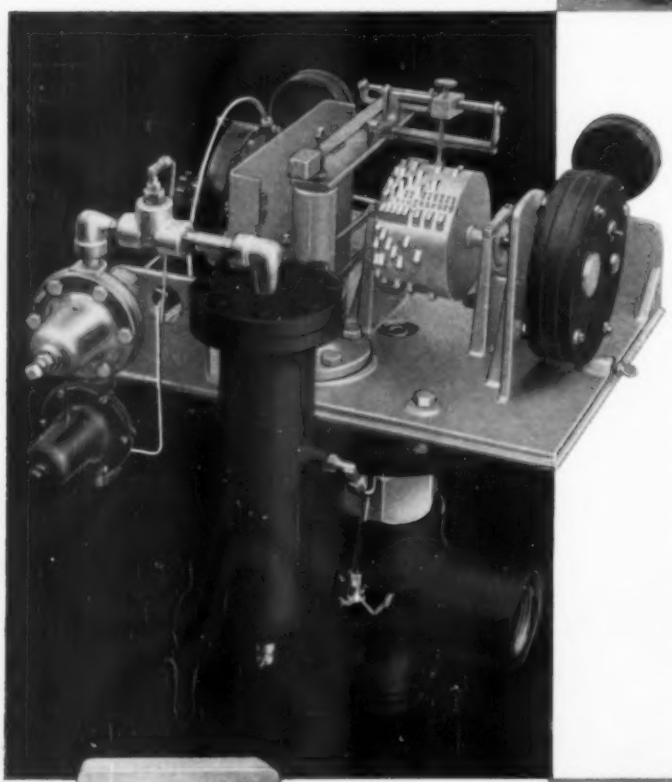
Construction almost completed, the major sections of the integrated refinery shape up as: (left to right) the saturate gas plant, the crude section, catalytic cracker, unsaturate gas plant, catalytic polymerization section, and the delayed coker.

Accurate Gas Lift Time Cycle Control With Finger-Tip Adjustments

GUIBERSON'S AF

Intermitter-Regulator





Here's a real *oil field tool.* A rugged, long lasting intermitter-regulator for gas lift, which can be accurately set by a field man *with his gloves on*.. no special tools needed.

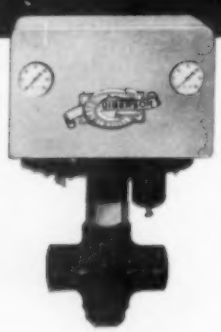
Note the intermitter-regulator with the cover removed. See how simple and trouble free the mechanism is.. no loose pins to set.. no tiny parts to adjust.

Select a time cycle by moving the adjusting screw along the slide bar until it lines up with the desired time embossed on the drum. Then set the injection time by turning the adjusting screw. Turning right increases.. left decreases.

Cycle frequencies are possible from an every five minute maximum to a minimum of one injection per revolution of the two-hour clock. Each cycle repeats with reliable accuracy.

For use as a pressure regulator, back off the adjusting screw until it clears timer drum tabs. Set to hold desired pressure with adjusting knob on the bourdon tube. It's as simple as that.

All parts are corrosion resistant and precision-made for long life and dependable service.



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ETHYLENE GLYCOLS FACTS BOOK!

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Learn all the facts about the use of Ethylene Glycols in the production of antifreeze, resins and plastics, plasticizers, solvents and coupling agents, electrolytic capacitors, explosives, natural gas, and in solvent extraction. Plus other mighty interesting data!

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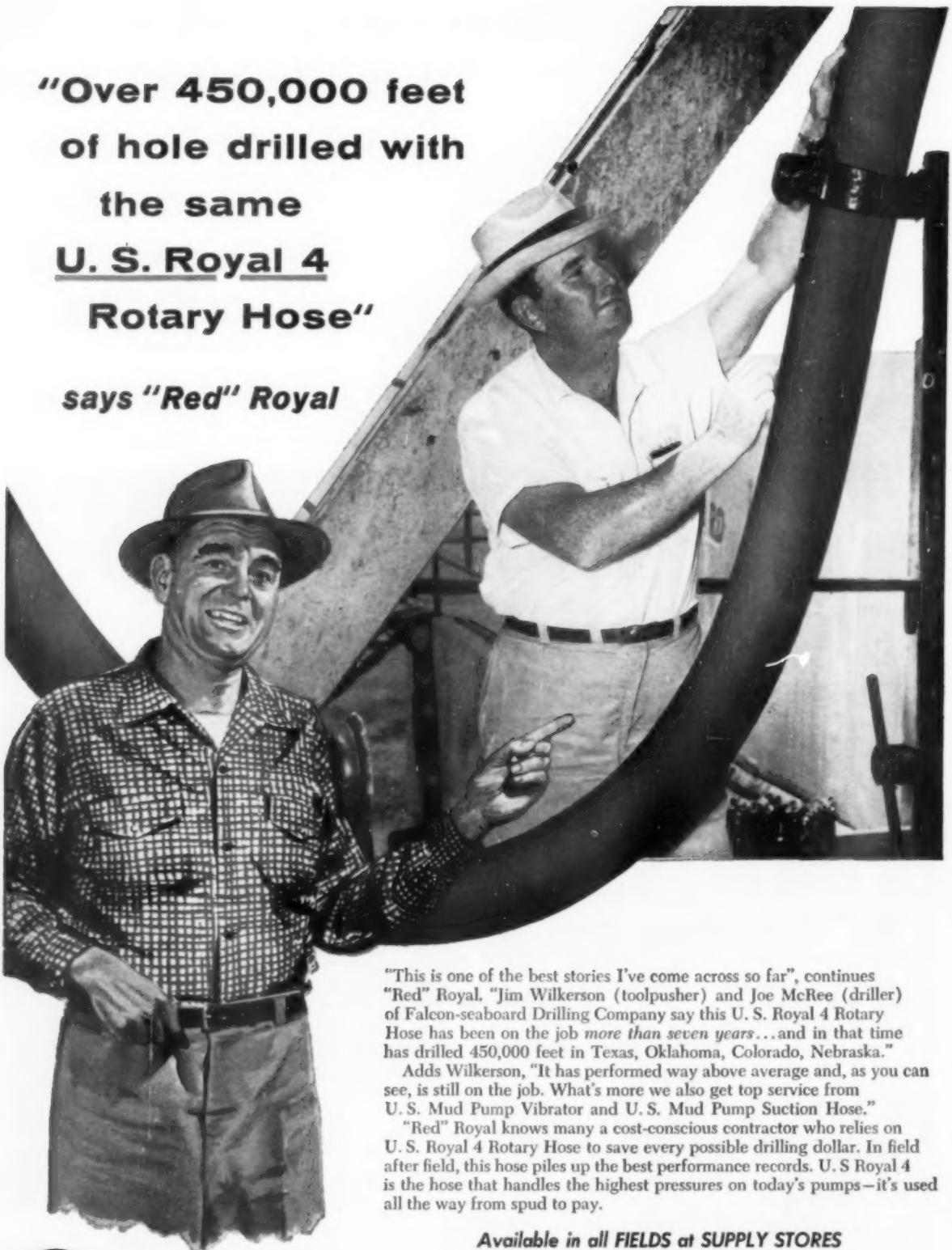
"Over 450,000 feet of hole drilled with the same U. S. Royal 4 Rotary Hose"

says "Red" Royal



"This is one of the best stories I've come across so far", continues "Red" Royal. "Jim Wilkerson (toolpusher) and Joe McRee (driller) of Falcon-seaboard Drilling Company say this U. S. Royal 4 Rotary Hose has been on the job *more than seven years*...and in that time has drilled 450,000 feet in Texas, Oklahoma, Colorado, Nebraska."

Adds Wilkerson, "It has performed way above average and, as you can see, is still on the job. What's more we also get top service from U. S. Mud Pump Vibrator and U. S. Mud Pump Suction Hose."

"Red" Royal knows many a cost-conscious contractor who relies on U. S. Royal 4 Rotary Hose to save every possible drilling dollar. In field after field, this hose piles up the best performance records. U. S Royal 4 is the hose that handles the highest pressures on today's pumps—it's used all the way from spud to pay.

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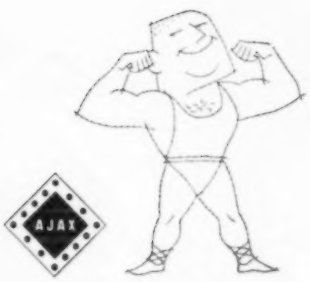
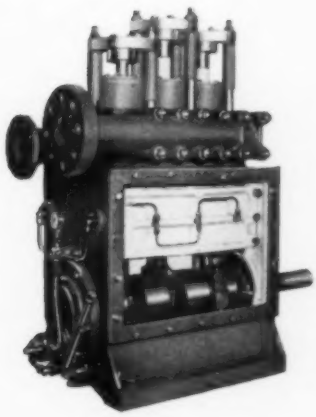
3 Great Performers—

IN THE FLUID INJECTION FIELD!

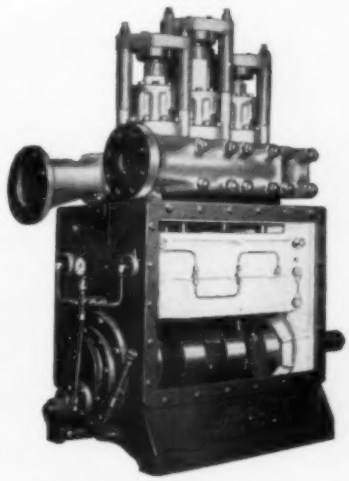


TRIPLEX 4000 PUMP

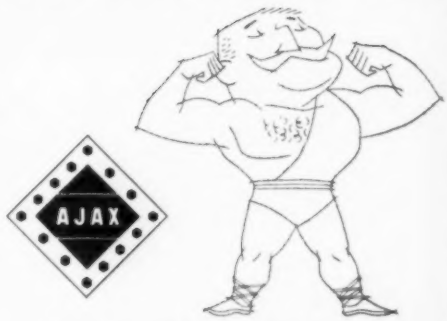


5.2 to 123.5 gpm
Pressures 4980 to 835 psi

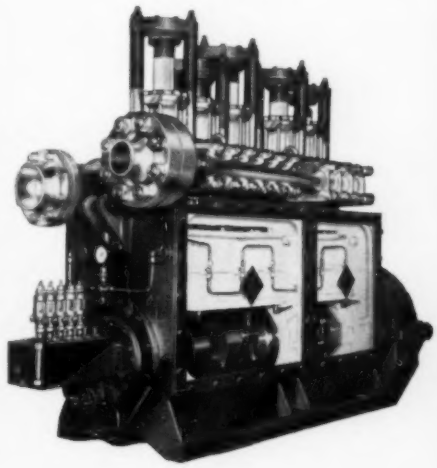
TRIPLEX 5000 PUMP



9.6 to 258.2 gpm
Pressures 4940 to 665 psi



QUINTUPLEX PUMP



16.0 to 430 gpm
Pressures 4940 to 665 psi

AJAX

Ajax Vertical Pumps offer a broad range of capacities for fluid injection and down-well pumping demands, with unfailing dependability for pressure maintenance around the clock. In the years since their introduction, Ajax Triplex Pumps have led the field in stamina and low maintenance on the toughest pumping jobs. The new Ajax Quintuplex brings high capacity with the same Ajax top quality construction—and is the *first* pump to feature a crankshaft mounted on THREE double-row, tapered anti-friction roller bearings. Typically AJAX . . . ask your Supply Man for descriptive bulletins!

AJAX IRON WORKS

Builders of GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM ENGINES

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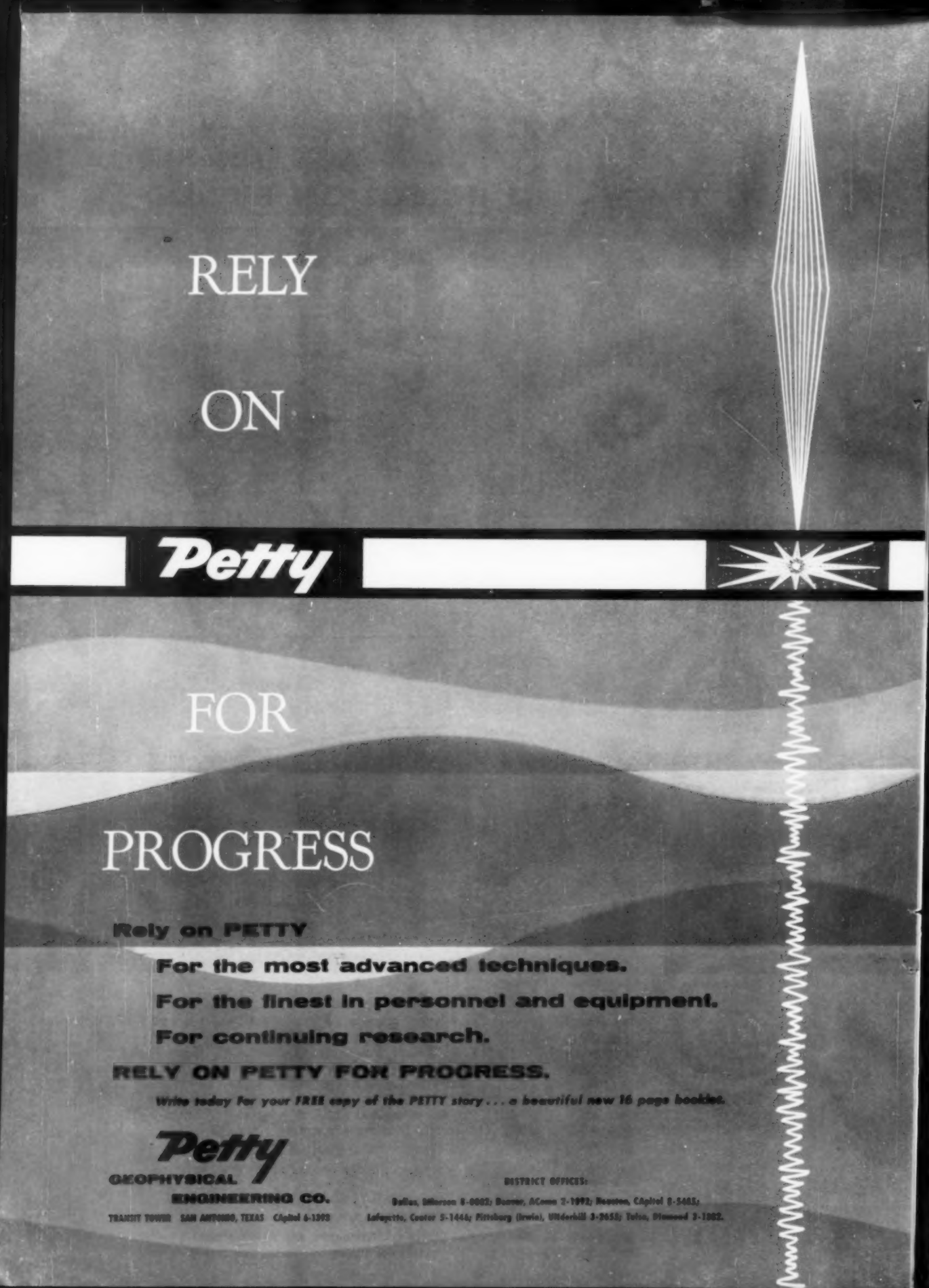
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For a free full color print of the above illustration, suitable for framing, send your request to the Oil Center Tool Company, P. O. Box 3091, Houston, Texas

Cane Crop or Crude... Louisiana has it

Louisiana grows good things—both above and below its rich soil.

The cane grows taller. The yams are more buxom. Towers of new industrial plants stab skyward.

An energetic and capable people are putting the things of nature to work—for themselves and for the world.

Oil has been the dominant force which has released this tremendous Louisiana energy.

This is the land of the Frio, the land of deep producers, the land of difficult completions.

The Oil Center Tool Company is proud to be a part of the development of this great State. O-C-T is a pioneer in well control equipment and its thorough research program has resulted in controls ideally suited for Louisiana problems of depth and pressure.

The new industrial muscle of the Pelican State is flexing in all directions. And the horizon is ever-widening.

Inset: A Louisiana Oil Landmark at Jennings.

O·C·T

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Step up safety, performance and service life with

Vogt

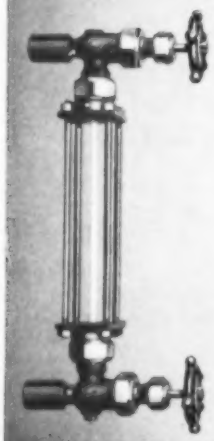
Rugged Vogt Drop Forged Steel Gauge Cocks on this Natural Gasoline Storage Tank at Warren Petroleum Corporation's San Pedro California Terminal, are unsurpassed for safety to contents and to plant personnel. If a gauge cock glass should be accidentally broken, balls in the gauge cocks would automatically shut off the liquid until repairs were made.

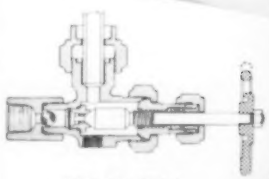
Reliable, trouble-free, outdoor operation year after year in exacting services of this kind is yours when you install Vogt Drop Forged Steel Liquid Level Gauges.

HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

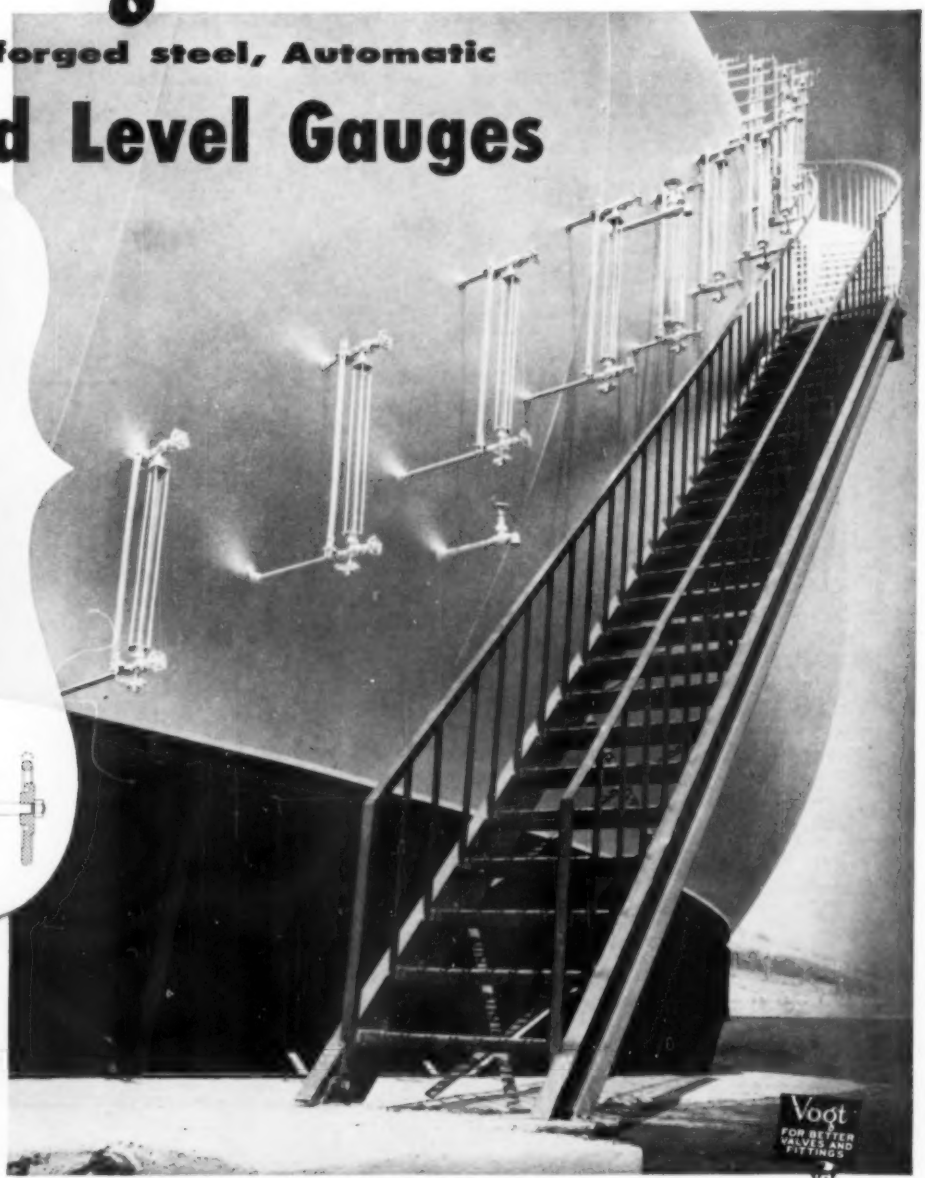
Drop forged steel, Automatic

Liquid Level Gauges





SECTION THRU GAUGE COCK



See Catalog F-9 for complete data on gauge cocks, trims, and gauge glasses for specific operating conditions or write Dept. 24A-FO.

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings, and Flanges • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.

This is the Figure 300 — the original flat-face union that blazed the trail others now follow. Introduced by Yale Machine Works in 1947, this union has been proved to be absolutely reliable. It is eleven years ahead of other similar unions, and that eleven years of service is your assurance of complete safety and satisfaction. This union already has been used under every conceivable condition of pressure and vacuum, with liquid, gas, steam and vapor.

When you buy flat-face unions — and a great many folks are buying them these days—be sure to get the original. Specify Figure 300 . . . and get proved performance, proved strength, proved design. Available at all recognized supply stores.

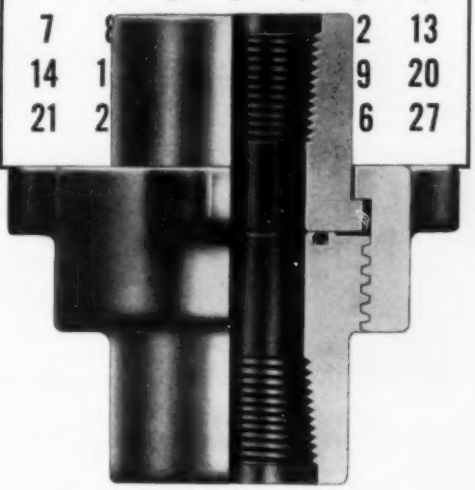


Figure 300 Unions are furnished in sizes from ⅛" through 12", for cold working pressures from 1000 to 10,000 psi. Supplied in color-coded steel, brass, and combination steel-brass, with hex or wing nuts. Special materials and finishes furnished on special order. For complete information on this and other unions manufactured by Yale Machine Works, write for Catalog No. 57.

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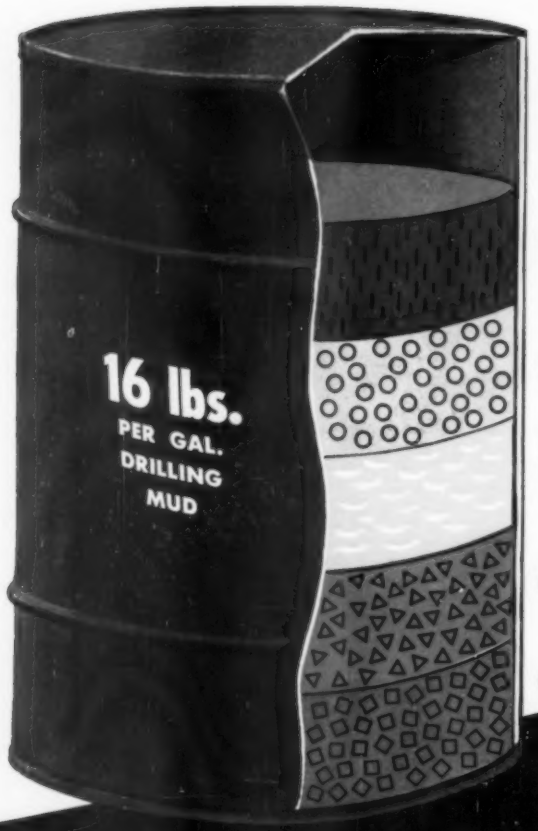

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ARE YOU JETTING AWAY DOLLARS?

...or are you discarding only worthless drilled solids?

You are jetting away money uselessly — if you aren't using the HOMCO Closed Circuit Dual Centrifuge. 16 pound mud costs from ten to twenty dollars per barrel. Are you jetting these barrels of dollars away? The HOMCO Closed Circuit Dual Centrifuge reclaims the barite, the emulsion, the chemicals, the water and DISCARDS ONLY THE DRILLED SOLIDS.

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HOUSTON OIL FIELD MATERIAL COMPANY, Inc.
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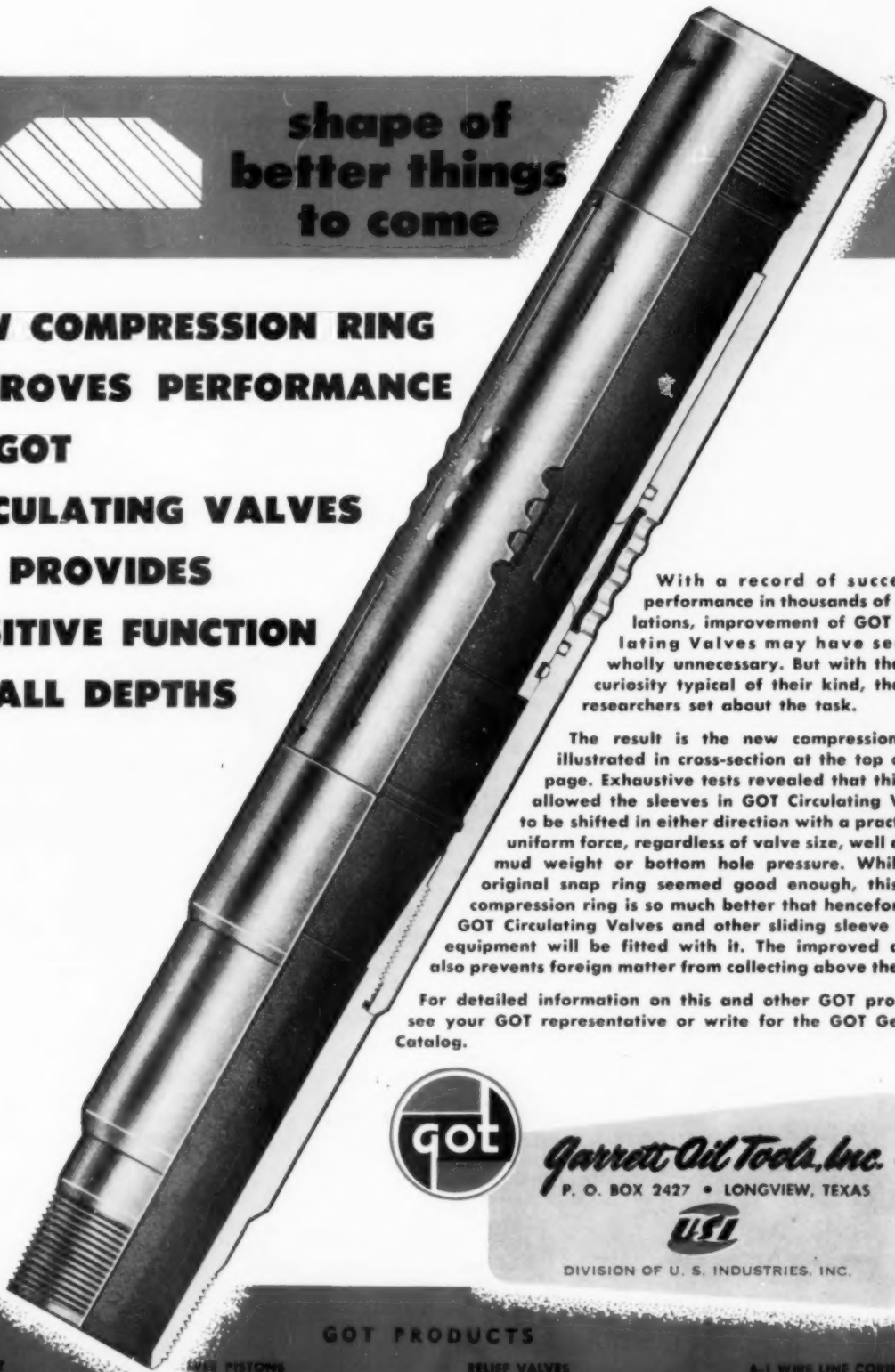
shape of better things to come

NEW COMPRESSION RING IMPROVES PERFORMANCE OF GOT CIRCULATING VALVES . . . PROVIDES POSITIVE FUNCTION AT ALL DEPTHS



With a record of successful performance in thousands of installations, improvement of GOT Circulating Valves may have seemed wholly unnecessary. But with the avid curiosity typical of their kind, the GOT researchers set about the task.

The result is the new compression ring illustrated in cross-section at the top of this page. Exhaustive tests revealed that this ring allowed the sleeves in GOT Circulating Valves to be shifted in either direction with a practically uniform force, regardless of valve size, well depth, mud weight or bottom hole pressure. While the original snap ring seemed good enough, this new compression ring is so much better that henceforth all GOT Circulating Valves and other sliding sleeve valve equipment will be fitted with it. The improved design also prevents foreign matter from collecting above the ring.

For detailed information on this and other GOT products, see your GOT representative or write for the GOT General Catalog.

got

Garrett Oil Tools, Inc.

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WICHTEX

Well Servicing Units

Wichtex units are a smart buy. They travel fast, work fast, reduce operating costs, and provide extra capacity per dollar invested. And, for long, trouble-free life, they're in a class to themselves.

Investigate Wichtex units before you buy any servicing unit! Models range from 2,000' to 12,000' capacity. Spudding attachment optional.

Also investigate WICHTEX ROTARY RIGS for 2,000' to 5,000' drilling.

WICHTEX MACHINERY COMPANY INC.
WICHITA FALLS TEXAS

P. O. Box 2250 Phone 322-8612

They Say

True situation in Canada

Dear Sir:

I would like to take this opportunity to compliment your Mr. Frank J. Gardner for his fine article entitled "Canada: Prime Hunting Ground for Oil," which appeared in your issue of May 26 (p. 51).

The article was well written and factual and demonstrated that Mr. Gardner became well acquainted with the true situation in Canada today. He certainly has his finger on the pulse of the oil industry in Canada and has diagnosed the patient's symptoms extremely ably.

I was especially pleased at Mr. Gardner's handling of the "anti-Americanism" myth. It has always been my experience that Canadians welcome American participation in the development of their oil and mining resources.

Thinking Canadians, to a man, realize that foreign capital, be it U. S., British, French, Belgian, etc., creates jobs for Canadians. They realize that undiscovered and undeveloped resources remaining stagnant in the ground do no one any good.

Canada has the potentiality to become a great nation in the years to come and, notwithstanding the tactics of certain small petty politicians, will realize its greatness. The twentieth century does indeed belong to Canada.

R. Walter Kulow
Olin Mathieson Chemical Corp.
Niagara Falls, N. Y.

Canadian story informative

Dear Sir:

I would like to take this opportunity to compliment you on the very informative article entitled, "Canada: Prime Hunting Ground for Oil" which was published in the May 26 issue of The Oil and Gas Journal (p.51). . .

C. F. Royse
Vice President, Sales
Fluor Corp. of Canada, Ltd.
Toronto

Who has deepest pumper?

Dear Sir:

Referring to page 108, The Oil and Gas Journal for May 19, "Pumping-Depth Record Broken." Pure had a well in West Poison Spider field, west of Casper, Wyo., pumping from 14,309 ft. in 1954.

Perhaps this article only pertains to currently pumping wells. I do not know whether the Pure well is still pumping.

T. Dean Mundorf
Geologist
Plymouth Oil Co.
Denver

(Editor's note: Pure Oil Co.'s West Poison Spider Unit No. 1 is producing from the Frontier formation at 14,309 ft., total depth. The pump is set at 7,033 ft., however. Mentioned in the story was Shell Oil Co.'s Lea County, New Mexico, well pumping from 13,000 ft.)

Mirror shows the villain

"When the oil industry looks today for the source of threats against it, more often than not it can look right in the mirror. Certainly a quick look at industry matters on which government action is being sought—action which affects the rights of big and small business—will reveal an oil source in many cases. . .

"Conflict among various segments of the oil industry, and among professional and trade associations in each segment . . . leads inevitably to political interest and to legislative proposals potentially dangerous to the entire industry. . .

"I do not think that any element of the oil industry wants or intends that its efforts to solve problems by government action should result in limitation of private enterprise or damage to the oil industry. But intended or not, if the effort is successful, such a result is as certain as the proverbial 'death and taxes.'

"Government doesn't get into something in a small way. . .

"The solution to our internal conflicts is a simple one . . . We must work together, settle our own affairs, and not bring the Government into the picture. . .

"But we must go beyond this point if we are to grow and prosper as one of America's greatest industries. . . We cannot complain about the treatment we receive from Government unless we have equipped ourselves to present our case to Government and to the public in a direct and forthright manner.

"If we want intelligent laws in connection with our business, we must take it upon ourselves to see that

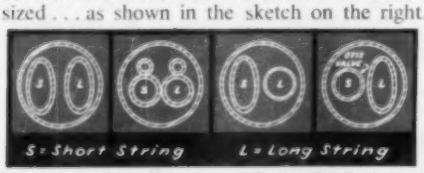
Carlos Canalizo, Otis Development Engineer and Gas Lift Authority, Says

"In times like these...can you afford to lose a dual well? You might, if you can't rotate the pipe."

DON'T RUN A RISK...RUN CONCENTRIC COLLAR-SIZED, FULL-OPENING OTIS TYPE C GAS LIFT VALVES FOR DUAL-COMPLETIONS

Q. Carlos, that's an alarming thing . . . losing a well these days. How can a single precaution like concentric valves save a well?

A. It's as simple as these diagrams. In any parallel-string completion, if two strings with *eccentric* mandrels are run, there is absolutely no way to rotate either string, because the valves will not clear the other tubing string. *However*, if the gas lift valves on at least one of the strings is an Otis Type C, that string *can* be rotated because the Otis valves are collar-sized . . . as shown in the sketch on the right.



In any dual well, you need the flexibility of being able to rotate the tubing. It is *desirable* in both strings, *but absolutely necessary* on the short string.

Q. You said the Otis Type C is full-opening and collar-diameter. Where's the valve mechanism?

A. The Otis valve is built *around* the mandrel rather than inside or alongside it. Thus it has an unrestricted bore, yet it's absolutely cylindrical. The 3 1/16" O.D. x 2" I.D. Otis valve is the only concentric, full-opening, collar-sized valve on the market. By the way, this valve also has an excellent application in slim-hole single-completions.

Q. Is the same design available in a removable valve?

A. Yes, in the Otis Type F that I'm holding in my left hand. The Type F is run and pulled with standard kick-over tools and wire line methods and can be seated in a conventional side-pocket mandrel or in an Otis retrievable concentric mandrel. The Otis concentric mandrel can also be rotated, and with the valves pulled, the bore is essentially full-opening.

Actually, our valves have more important, exclusive operating features than any valve on the market. If you will contact one of the many Otis branches throughout the oil country, they will be glad to advise you on selecting the best string of valves for your wells. You will find them friendly, courteous, and well qualified, and anxious to help you at all times.

OTIS Engineering CORPORATION

Branches Throughout the Oil Country

PARKERSBURG DAU*

WELSORBERS AND WELDRIERS

Put Your Problem to Parkersburg's Engineering Know-How to show you where to locate a DAU Welsorber or Weldrier and give you an accurate picture of distillate recovery possibilities.*

**Dynamic Adsorption Units, a Parkersburg Original (Patented).*

PARKERSBURG ORIGINATED AND STILL LEADS IN DEHYDRATION-HYDROCARBON RECOVERY UNITS

1 Parkersburg originated unitized short cycle Dehydration-Hydrocarbon Adsorption Units in 1952.

2 The *only complete line* of Dehydration-Hydrocarbon Adsorption Units. Dehydration capacities from 1 million to 100 million standard cubic feet per day. Distillate recovery capacities from 7.5 Bbls/Day to 135 Bbls/Day stable stock tank oil.

3 Parkersburg units are ready to go *on-stream* when they are delivered to location. *No costly extra accessories are needed. No field insulation of towers is required.*

4 Parkersburg has trained technical personnel in all Production Equipment Division Branch offices capable of installing and operating DAU Welsorbers and Weldriers. No factory "experts" have to be flown in to iron out experimental "bugs".

5 Parkersburg DAU Units have been proven by six years of rugged testing and field service.

6 Parkersburg DAU Units are self-contained, with all necessary controls for completely automatic, unattended operation anywhere, regardless of location. No external source of energy is required. No shutdowns due to electrical and other power failures.

Factual Comparison

of the Parkersburg DAU with similar equipment now on the market.

		Parkersburg	Unit X	Unit XX*
1	How many short cycle dehydration—hydrocarbon adsorption units are built and in operation?	72	3	1
2	How many years have these units been in operation in the field?	5½	1½	½**
3	How many different models of units are advertised as being available?	27	2	1**
4	Is power pump required for the operation of the unit?	NO	YES	YES
5	Is the unit complete with inlet separator as part of the "package"?	YES	NO	NO
6	Are any units operating on offshore platforms?	YES	NO	NO
7	Are any units operating in sub-zero climates?	YES	NO	NO
8	Are any units operating on hot compressor discharge gas?	YES	NO	NO
9	Are any units processing full wellstreams, serving as separation, dehydration, AND hydrocarbon recovery equipment?	YES	NO	NO
10	Are any units "riding" gas pipelines, serving as dehydration and hydrocarbon recovery equipment?	YES	YES	YES**

*Conventional Unit, converted to short cycle for experimentation
**Experimental Unit

You can put your problem to PARKERSBURG'S ENGINEERING KNOW-HOW . . . the same know-how that originated and still leads in dehydration-hydrocarbon recovery units.

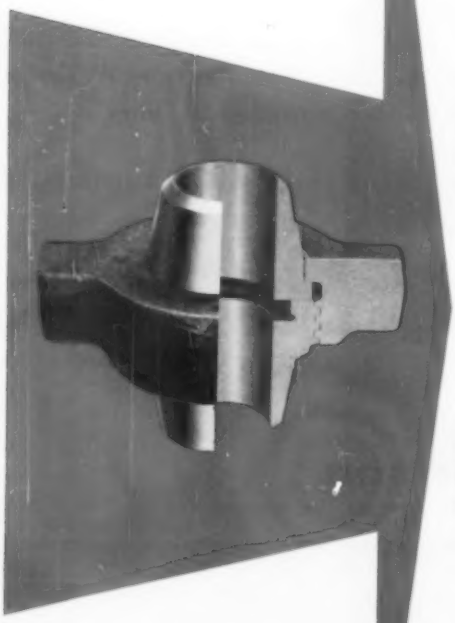
THE PARKERSBURG RIG & REEL COMPANY
Division of Parkersburg-Aviza Corp.
PRODUCTION EQUIPMENT DIVISION OFFICES: P. O. BOX 13295, HOUSTON 19, TEXAS

NEW WECO FLAT FACE UNION

Figure 415
Figure 615

Sizes: 2", 3", 4"

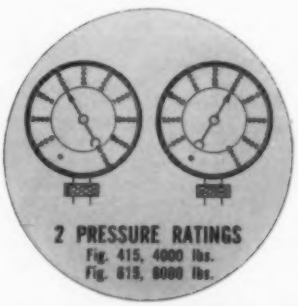
Pressures:
4000 psi test
and 6000 psi test



EASY TO INSTALL
Slips in like a flange

POSITIVE SEALING
Resilient seal ring under compression between subs

3 TYPES END CONNECTIONS
Butt Weld— Socket Weld— Threaded



2 PRESSURE RATINGS
Fig. 415, 4000 lbs.
Fig. 615, 6000 lbs.

Weco Flat Face Unions are stocked by supply stores everywhere. Order WECO Flat Face Unions when you need simplified, easy make-up of connections in limited space installations.

U-12-58

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HOUSTON, TEXAS

WECO

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

government officials are acquainted with the mechanics of the oil industry. . ."

E. B. Paust, general counsel, Esso Standard Oil Co., in a speech to the Associated Petroleum Industries of Delaware, Dover, Del.

Socony against wage boost

"We are deeply concerned about mounting operating costs. . . .

"Operating costs cannot be controlled if wages increase faster than labor's contribution to greater productivity. This has been occurring faster and, in my judgment, cannot go on. We at Socony Mobil see no economic justification for a general wage increase this year.

"Looking beyond the oil business at the broader picture, American industry stands in real danger of pricing itself out of world markets if wage rates advance without regard for economic realities . . ."

Albert L. Nickerson, president, Socony Mobil Oil Co., in a speech to company shareholders.

Carson's speech to TIPRO

"Your statement (at TIPRO's annual meeting) that strict compliance with the 1954 ratio (in 1957) would have increased Texas production only about 3 gal. a day per well . . . has been construed by some as a literal fact that producers are losing only a few cents a day as a result of excessive crude-oil imports. . .

"Using the same period of your reference, our calculations indicate that strict adherence to the 1954 ratio between domestic production and oil imports into Districts 1-4 would have made a difference in crude oil alone of—not 3 gal. per well—but of some 18 gal. per well per day.

"And using what we believe is a more significant period and a more realistic base generally, the difference would approximate 3 bbl., not gallons, per well, which represents some 25% of the average production per well. . ."

Lester Clark, executive committeeman of Texas Independent Producers and Royalty Owners Association, in a letter to Capt. Matthew V. Carson, voluntary imports plan administrator.

CALENDAR

JUNE

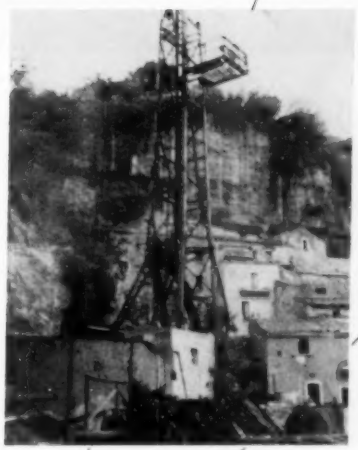
28-July 2 Petroleum Equipment Suppliers Association, twenty-third annual meeting, Chateau Frontenac, Quebec.

JULY

23-26 Wyoming Geological Society, thirteenth annual field conference, Powder River basin.

AFRICA

ITALY



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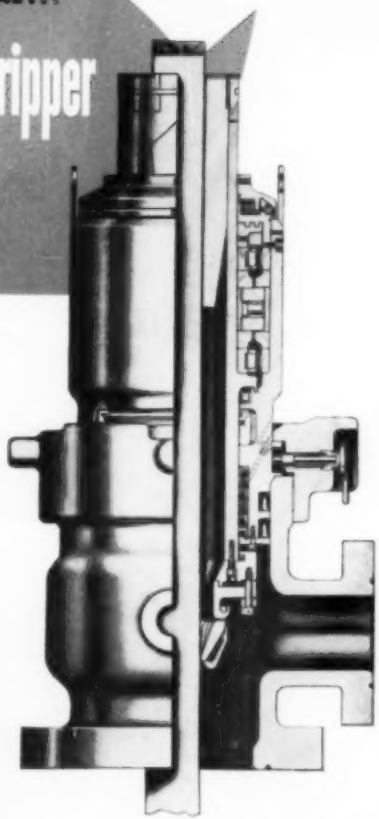
WHERE CONTINUOUS PRESSURE CONTROL IS VITAL...

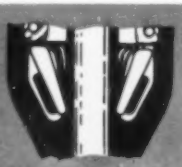
The Shaffer Rotating Blowout Preventer and Stripper IS UNEQUALLED!



WHENEVER you're drilling in unknown formations—or in troublesome zones where pressures are a problem—make sure you install the unequalled protection you get with the Shaffer Rotating Blowout Preventer and Stripper.

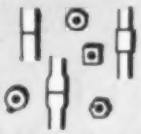
HERE'S a unit that maintains *continuous* pressure control as long as the drill string is in the hole—whether the string is rotating, is being raised or lowered, or remains stationary. Since pressure control is continuous, emergencies can't happen too fast for this unit, because it is *always* sealed off around the drill string until the string is removed from the well. Note the many unusual features as outlined below...

***PRESSURE SEAL IS CONTINUOUS*—not only while running the varying shapes of the drill string in and out of the hole, but also during rotation and while pipe is stationary. Moreover, the sealing unit automatically adjusts itself to maintain its seal. No manual operations are necessary!**



***PROTECTIVE STEEL BARRIER* of flexible latches protects the Stripper Rubber against damage as varying shapes and diameters pass through the unit. This flexible steel barrier also protects the Rubber from extruding under high well pressures!**

Note space-saving compactness. Even flow-line connections are built-in, eliminating need for spools.



***SEALS VARYING DIAMETERS AND SHAPES* because the Stripper Rubber *automatically* expands and contracts to maintain a pressure-tight seal around the elements in the drill string—the varying diameters of flush, upset and coupled pipe, drill collars, subs, etc.... and any shape kelly, whether square, hexagon or octagon!**

***SEPARATE THRUST AND RADIAL BEARINGS* carry all rotating loads, assuring maximum efficiency under any combination of horizontal and vertical loads. And since the Stripper Rubber rotates *with* the kelly—not around it—wear and flexing of the Rubber is negligible and the seal remains pressure-tight!**

***LARGE DIAMETER TOOLS,* such as bits, reamers, etc., are easily passed through the unit by simply rotating the Bonnet 1/6 turn. This unlocks the internal mechanism so that any equipment that passes through the casing will also pass through the unit.**

See the Shaffer Section of your Composite Catalog.

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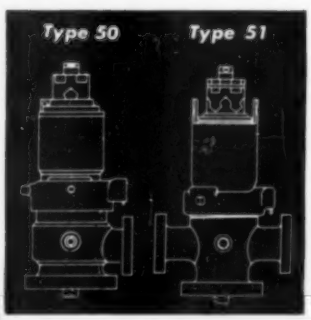

Available In Two Types:

Type 50 **is for drilling through 10¾" Casing or larger.**

Type 51 **is for slim-hole drilling, drilling-in, production and re-work operations.**

Both types have the same basic design advantages!

Our nearest Shaffer representative will gladly supply full details. Or write direct!

24 Illinois Oil and Gas Association, American Petroleum Institute, joint meeting and annual oil men's outing, Meadow Woods Country Club, Centralia, Ill.

AUGUST

11-14 Society of Automotive Engineers, National West Coast meeting, The Ambassador, Los Angeles.

18-19 North Dakota Oil and Gas Association, annual meeting, Grand Pacific Hotel, Bismarck, N. D.

18-20 American Institute of Chemical Engineers, American Society of Mechanical Engineers, second annual heat-transfer conference, Edgewater Beach Hotel, Chicago.

19-22 American Institute of Electrical Engineers, general meeting, Sacramento.

25-27 Appalachian Gas Measurement Short Course, University of West Virginia, Morgantown, W. Va.

SEPTEMBER

7-12 American Chemical Society, fall meeting, Chicago.

10-12 National Petroleum Association, fifty-sixth annual meeting, Traymore Hotel, Atlantic City, N. J.

10-13 Intermountain Association of Petroleum Geologists, ninth annual field conference, Paradox basin.

14-19 Instrument Society of America, thirteenth annual instrument-automation conference and exhibit, Convention Hall, Philadelphia.

15-16 Independent Natural Gas Association of America, annual membership meeting, Roosevelt Hotel, New Orleans.

15-17 American Institute of Electrical Engineers, conference on petroleum, Baker Hotel, Dallas.

18 Natural Gasoline Association of America, Rocky Mountain regional meeting, Gladstone Hotel, Casper, Wyo.

21-24 American Society of Mechanical Engineers, petroleum division, mechanical engineering conference, Cosmopolitan Hotel, Denver.

24-25 Western Petroleum Refiners Association, Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

25-26 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, annual meeting, Roosevelt Hotel, New Orleans.

29-Oct. 3 Society of Automotive Engineers, national aeronautic meeting, aeronautic production forum, and aircraft engineering display, The Ambassador, Los Angeles.

OCTOBER

1-2 Western Petroleum Refiners Association, third annual stream-pollution and waste-disposal conference, Lassen Hotel, Wichita.

1-3 American Association of Oilwell Drilling Contractors, eighteenth annual meeting, Adolphus and Baker Hotels, Dallas.

3 American Institute of Chemical Engineers, South Texas section, thirteenth annual technical meeting, Moody Center, Galveston, Tex.

5-8 Society of Petroleum Engineers of AIME, fall meeting, Houston.

5-8 National Association of Corrosion Engineers, northeast region, Somerset Hotel, Boston.

7-8 Texas Mid-Continent Oil and Gas Association, annual meeting, Statler-Hilton Hotel, Dallas.

in 20,058 B.C. smart men didn't try to control electricity

in 1958 smart men depend on electrical control equipment from

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

a major source of electrical control equipment for industry

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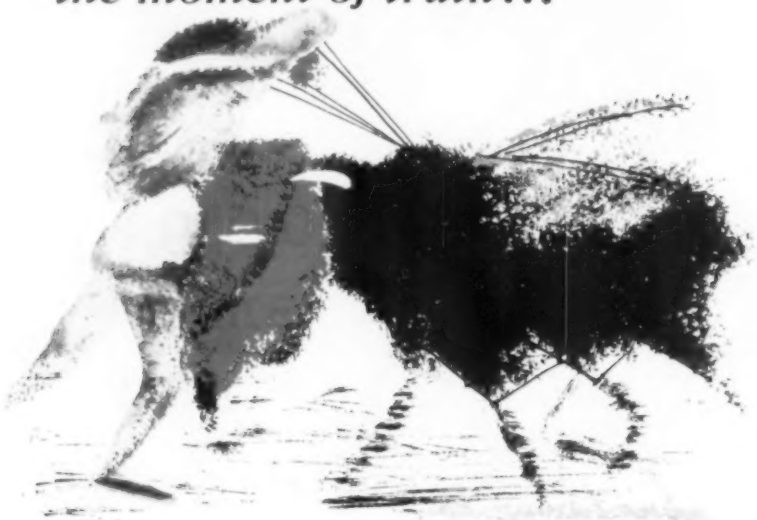
the moment of truth...

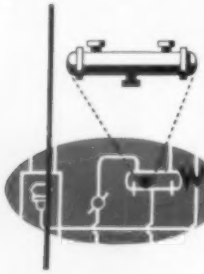


...about electronic computers and heat exchangers

Nobody disputes the accuracy of electronically-computed findings or calculations, but in the solution of heat transfer problems, the electronic computer performs only one of several important steps.

At the core of Western's reputation for designing and building heat exchangers of true quality and long-life efficiency, is the step that follows our electronic computations: the precise and pertinent interpretation of these findings in the light of our engineers' combined experience in the heat transfer field, as well as an intimate knowledge of each customer's needs.

The results of electronic wizardry are valuable only if you know how to use them.



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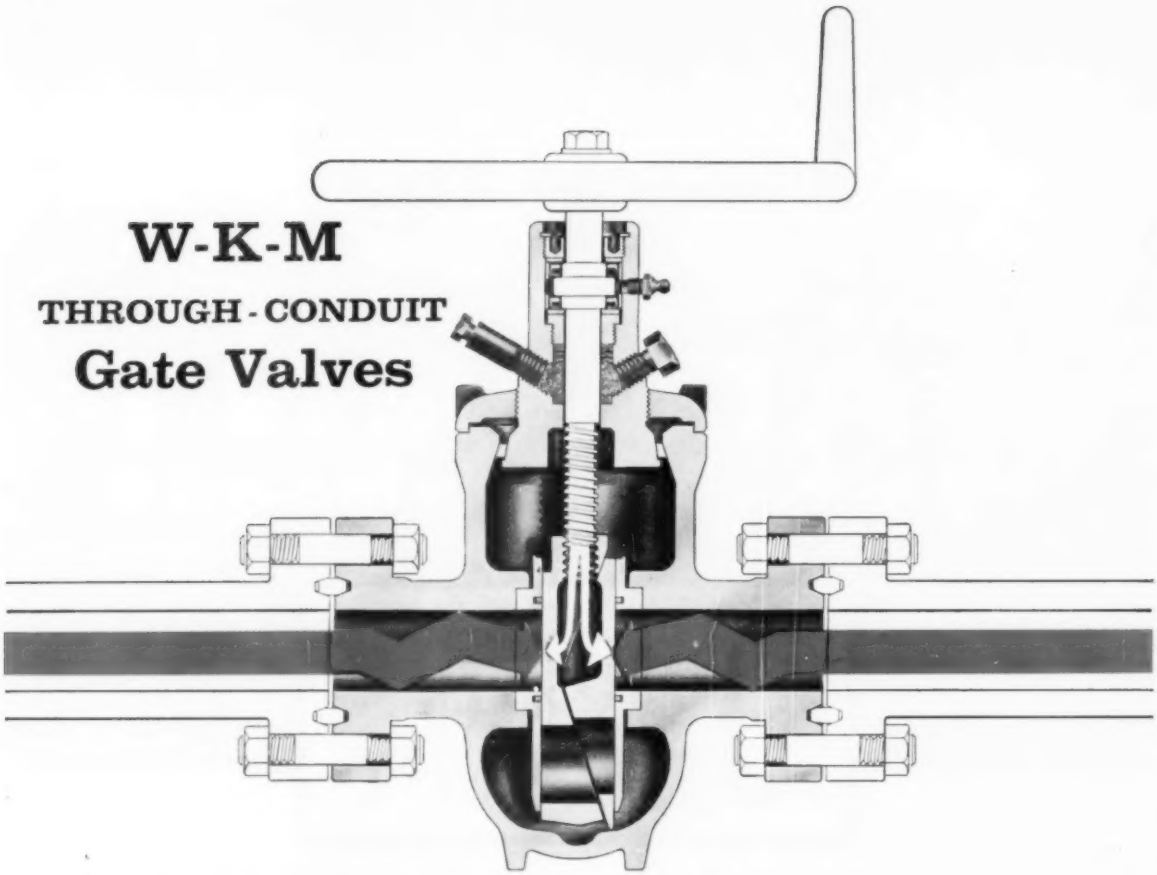
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma

9-10	California Natural Gasoline Association, thirty-third annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
12-18	OIL PROGRESS WEEK.
13-15	American Gas Association, annual convention, Atlantic City, N. J.
13-15	American Society of Mechanical Engineers, American Society of Lubricating Engineers, conference on lubrication, Statler Hotel, Los Angeles.
13-16	Society of Exploration Geophysicists, annual meeting, Hotel Gunter, San Antonio, Tex.
13-17	American Society of Civil Engineers, annual convention, Hotel Statler, New York.
15-16	South Dakota Independent Oil Men's Association, convention, Sheraton-Johnson Hotel, Rapid City.
15-17	National Association of Corrosion Engineers, north central region, Cincinnati.
16-17	Society of Petroleum Engineers of AIME, Southern California petroleum section, Biltmore Hotel, Los Angeles.
16-18	New Mexico Geological Society, Arizona Geological Society, ninth annual field conference, Black Mesa basin, registration Gallup, N. M., Oct. 15.
19-21	National Association of Oil Equipment Jobbers, annual convention and trade show, Hotel Adolphus, Dallas.
20-24	National Association of Corrosion Engineers, south central region, Roosevelt Hotel, New Orleans.
22-23	National Association of Corrosion Engineers, western region, corrosion control course, U. S. Grant Hotel, San Diego, Calif.
22-24	Southwestern Federation of Geological Societies, technical meeting, Mineral Wells, Tex.
22-24	Society of Automotive Engineers, national diesel engine meeting, Lord Baltimore Hotel, Baltimore.
23-24	Rocky Mountain Oil and Gas Association, annual fall meeting, Town House Motel, Omaha.
23-24	Western Petroleum Refiners Association, refining technology and industrial relations meeting, Rufus Garrett Hotel, El Dorado, Ark.
27-28	Independent Petroleum Association of America, annual meeting, Statler-Hilton Hotel, Dallas.
26-31	American Institute of Electrical Engineers, general meeting, Pittsburgh.

NOVEMBER

5- 6	Society of Automotive Engineers, national fuels and lubricants meeting, Mayo Hotel, Tulsa.
6- 7	American Association of Petroleum Geologists, Pacific section annual meeting, Los Angeles.
10	Transportation Club of the Petroleum Industry, annual meeting, Bismarck Hotel, Chicago.
10-13	American Petroleum Institute, thirty-eighth annual meeting, Conrad Hilton, Palmer House, and Congress hotels, Chicago.
18-20	Ninth National Conference on Standards, Hotel Roosevelt, New York.
21	Natural Gasoline Association of America, Panhandle Plains regional meeting, Herring Hotel, Amarillo.
30-Dec. 5	American Society of Mechanical Engineers, annual meeting, Statler and Sheraton-McAlpin hotels, New York.

W-K-M
THROUGH-CONDUIT
Gate Valves



Controlled force seating gives a leak-proof seal upstream and downstream

The parallel expanding gate in the W-K-M Through-Conduit Gate Valve gives you the force for safe, positive control of pressure, upstream and downstream.

As you turn the valve stem, the force is applied equally to both seats. It is not and cannot be applied while the gate is moving, because the gate and segment are held in a collapsed, free-moving position by alloy steel gate springs.

When gate and segment reach closing position, the segment stops, while the gate continues to move downward, forcing both gate and segment against the valve seats. The tighter the valve is closed, the greater the sealing force applied to both upstream and downstream seats. *This "controlled-force" seating gives you a leak-proof seal.*

When you open the valve, the valve stem releases the sealing force so that gate and segment move freely to a fully open position.

Specify W-K-M Valves for Christmas trees, flow wings, and all installations.

On Hand

Order W-K-M Valves from your supply store. Sizes 1½-inch to 4-inch; working pressures 500 lbs. to 15,000 lbs. . . . W-K-M field service men are everywhere there's oil.

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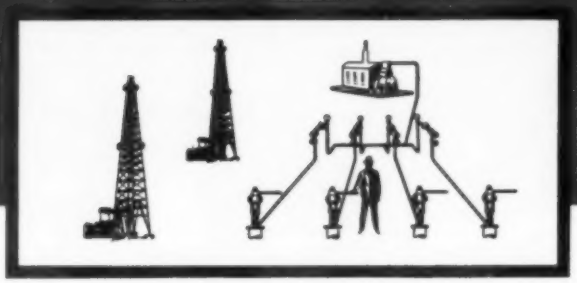
W-K-M's *Creative Engineering* **can assist you with any special problem. If it involves flow of fluids or gases through valves, check first with W-K-M.**

5805

WATCH

SARGENT

PUMP PERFORMANCE



UNDER THE TOUGHEST FIELD CONDITIONS

For 38 years Sargent has successfully worked in research, development and manufacture of oilwell, aircraft, marine, missile, and electronic equipment. The vast knowledge and experience gained through successfully engineering and manufacturing products in these highly advanced fields has been incorporated into building the finest pumps in the oilfields. Sargent builds every API classified pump obtainable with metals to fit any and all well conditions.

In 1924 the first Sargent hydraulic pump patent was obtained (patent #1,503,602).

Through years of research, re-design and refinement, Sargent now manufactures the pump proven to be the most efficient rodless, long stroking, bottom hole hydraulic unit obtainable, which actuates the time-proven bottom hole pump. Sargent provides the most complete service in the industry by company trained experts through company operated field stores.

The outstanding features of the Sargent rodless, long stroking, free or conventional design hydraulic pump are: • More volume • Wide selection of proven metals and design • Higher efficiency in gassy wells • Simple, yet rugged construction • Service in the fields (at the point of operation).

That's why you can "Watch Sargent" pump performance anywhere in the world under the toughest field conditions and learn for yourself that results prove "Sargent Builds 'em Better"!

"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
— U.S. Supreme Court

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TULSA, OKLAHOMA

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Riverside 8-3074
PREN G. HOLLINGSWORTH . . Representative

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GEORGE O. RUPPERT . . . . . District Manager

ENGLAND
National Provincial Bank Chambers
15 Grafton Street, Altrincham
Phone Altrincham 3160
HARRY BECKER . . . European Representative

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JOURNALLY SPEAKING

Plane Policy

THERE ARE A lot of unusual things about oil operations in the Four Corners area, as the Journal's Carl Hoot discovered while out there on a field trip recently.

And one of the most unusual is the extensive use of airplanes to get around, which Carl describes in a piece in the news section of this issue.

But this isn't a picture of Carl getting into one of the planes. It's a shot he took of an aerial hitchhiker bumming a ride of only a few miles—which is one of the unusual things about this unusual air taxi service.

This fellow works for Shell Oil Co., and the plane is operated by Four Corners Pipe Line Co. which is principally owned by Shell. So there shouldn't be anything strange about this. But the fact is, according to Carl, that the subsidiary's gagers, pumpers, and other workmen regularly get ferried all over the field, while employes of the parent company have to get around the best they can by surface transportion.

The area is so cut up with canyons and so devoid of good roads that getting around is really a serious problem. Take this fellow in the picture, for instance. He was working on a Shell lease on one side of the San Juan River, just a few miles from his home on the other side. But the river rose so high that he couldn't get across and had been stranded on the job for a week—and had 7 days' growth of whiskers to prove it.

Fortunately for him, the Four Corners pilots are very accommodating, and whenever they have an empty seat they cheerfully fly almost anybody around the area—including even employes of their parent company. The Four Corners men, understandably, get a big laugh out of the fact that they get airlifted to and from work while the Shell men in the same area have to humble themselves to beg rides or else stick to terra firma. There probably are good reasons for it, but nobody in the field understands this divergence of policy within the same company family, but that's only one of the things about the oil business that are hard to understand.

Our man Hoot, as well as this stranded lease worker, benefited from the good nature of the Four Corners pilots. Otherwise Carl might be out there yet. After being dropped off in the field on one of the regular runs from Farmington, Carl spent much of the day riding around in a jeep with a gager.

Leaving one well, the gager pointed to another one only a couple of locations away across a canyon, and remarked that it would take 9 miles of hard driving to get to it. But Carl was game, even though he had to sit on the hard radio box while the jeep bounced around over the so-called road. He got so interested in taking pictures of the area that he forgot all about the passage of time until a plane began buzzing the jeep and the radio began to squawk like mad.

It was Carl's pilot ready to take him back to town. So the jeep pulled up to a level spot, the little plane sat down and picked up our boy, and everything worked out on schedule.

—Henry D. Ralph

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Where there is a need... Baker shows the way. Recognizing a need for an economical, retrievable and yet dependable packer for water flooding and other pressuring applications in shallow or low fluid wells, Baker engineers have come up with the new Model "A" Tension Packer.

Compact design makes the big difference in this new packer. Imagine the ease of shipping, storing and handling a packer less than 30″ long. Its size is deceptive, for it contains many field-tested features of Baker retrievable squeeze tools.

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Conservation needs new stimulus and direction

ATTENDANCE at the semiannual meetings of the Interstate Oil Compact Commission always leaves a feeling of frustration. There is so much more that could be done, so much more progress that could be made in conservation and effective recovery of oil and gas.

This is not to belittle what has been done. The Compact has made incalculable contributions to the industry and to the national welfare in promoting sound management of an irreplaceable natural resource.

BUT TODAY NEW CONCEPTS of conservation are needed to meet new problems facing the industry and the nation. The past 25 years have established the basic engineering and legal principles of conservation. Now we need to advance in their refinement and application.

The growth of imports and the shift of the balance of producing power to foreign countries make it imperative that U. S. production be more efficient and competitive with foreign oil. Conservation regulations should be molded to that end.

The prospect held out to consumers that unlimited quantities of low-cost foreign oil can meet all future needs makes conservation of domestic resources seem less important to the general public. So there is a growing undercurrent of attack on proration and other conservation restrictions.

Much educational work must be done to defend and extend conservation. And the Compact Commission should be equipped with the spirit and the talent to take the lead in this.

Much educational work could also be done among oil producers and state regulatory officials, all of whom are prone to be so involved with details of their own immediate problems that they lose sight of broad objectives and new advances.

There is hardly a producing state that does not need to reexamine and modernize its conservation practices to fit them to the problems and conditions ahead. Among such might be mentioned the growing importance of secondary reserves, new methods of increasing ultimate maximum recovery, encouragement of deep drilling, and carrying a standby excess producing capacity.

THE IOCC SHOULD TAKE THE LEAD in all this and carry the torch for progress in conservation more zealously than ever before. No other agency could do it so well.

This can be achieved only through more active assistance from oil companies, large and small, who believe in the future of the domestic industry. Contributions of leadership, guidance, brainpower, and manpower from the industry could stimulate this voluntary organization and make it ever so much more effective in the future.

NICKEL MAKES ALLOYS PERFORM BETTER LONGER. After four years pumping duty, string of Bethlehem Steel ⅞-inch "46" sucker rods were still on the job. 3350-foot well in the Arbuckle formation produces daily 100 bbl. water, 20 bbl. 34-gravity oil. Rods are AISI 4621 nickel-molybdenum steel (1.65 to 2.00% Nickel), normalized and tempered.

38 million strokes in a corrosive formation and still no sign of failure in the nickel steel sucker rod string. That's because nickel steel rods are strong and tough... and provide a combination of corrosion and fatigue resistance to withstand high cyclic stresses. Get the superior mechanical properties and corrosion resistance you need in equipment... specify Nickel alloy steels!

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y. INCO NICKEL

A DECADE was needed to get this Seeligson well and 464 others into a unit which has 14,240 acres and 58 reservoirs.

Huge Texas Recovery Project Started

• Gas injection and water flooding of Seeligson field is aimed at increasing liquids recovery by 60 million barrels, and income by almost $200 million. Full-scale development of the operation is expected within a year.

ONE OF THE most complex pressure-maintenance projects in oil history is moving rapidly toward full-scale development.

Under way is the interlocking gas injection and water-flooding program in huge, multireservoir Seeligson field in South Texas.

The $1,500,000-program calls for simultaneous pressure-maintenance or cycling operations, or both, in an unprecedented 18 separate reservoirs underlying the 14,240-acre Seeligson unit.

Actually the big unit takes in 58 separate Frio sand reservoirs between 4,400 to 6,300 ft. Only 18 of these are felt large enough to support economic fluid-injection programs, however. These have 97.9% of the recoverable oil reserves and 67.2% of the recoverable gas reserves within the unit area and depth.

Of the rest, 10 have too little oil to justify pressure maintenance and too little gas reserves for cycling, 14 are small oil zones performing satisfactorily, and 16 are associated gas zones too small to cycle.

The unit takes in the entire field with the exception of two leases at the northeast end—Humble Oil & Refining Co.'s big King Ranch Seeligson lease and the Wilson-Rawlinson lease.

The unit includes 543 wells and 791 completions. The completions include active producers, all wells in the injection program, and some shut-in wells. In addition, Seeligson field also takes in more than 200 wells outside the unit.

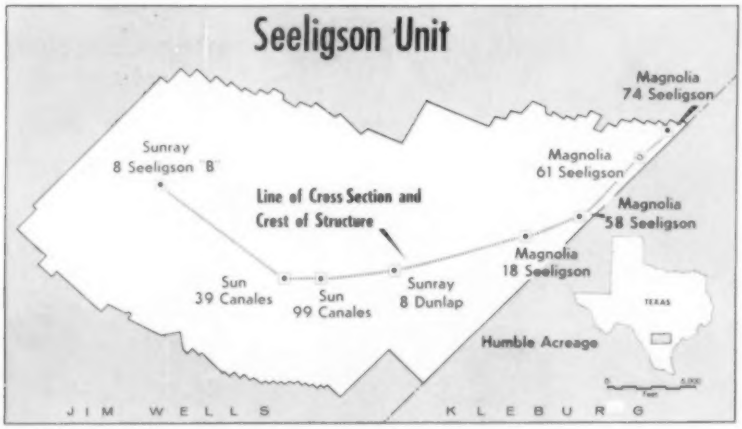
Despite its present size, the unit can be extended both laterally and vertically. It already is considering the feasibility of taking in some deeper pay zones where development is not far along.

Injection gaining . . . Sun Oil Co., Seeligson unit operator, has made a lot of progress in getting the program under way since the changeover to unit operation March 1.

Already 17 gas input wells are in service taking between 3 and 4 billion cubic feet of gas a month. Part of this volume is being pumped into the caps of the major oil reservoirs to maintain pressure and control cap movement. The rest is used in cycling gas caps of larger oil reservoirs and the thin oil columns of other pools.

Water injection is just now getting under way. Only one water input well so far is in operation. Three more have been approved by both engineering and operating committees and will be in service momentarily. Fifteen more have been selected by the engineering committee but are not yet approved by the operators.

The entire operation is slated to be fully developed within a year. By then the unit will be injecting around 150,000,000 cu. ft. of gas and roughly 22,000 bbl. of water daily. It will have 20 or more wells taking gas and about



the same number of water input wells.

The water-injection portion of the operation will be developed deliberately. First water is being injected in the northwest sector of the field. When the injection facilities in this area are complete and in full operation, the unit will move around the field periphery developing the program sector-by-sector.

All input wells, according to present plans, will be converted producers.

Part of the injection-water supply will be cooling or "blowdown" water from the big Seeligson gas plant. The rest will come from a prolific water-bearing formation which underlies most of the field.

The water will need little treating. The unit will use a closed system. Sun thinks it can get away with using only filtering equipment.

Though it isn't in the cards right away, Sun may supplement its huge gas and water-injection program later with miscible-phase drives in at least two reservoirs.

Tremendous job . . . Developing an operation so complex has been a back-breaking chore.

It began more than a decade ago in 1946 when field operators started work to unitize gas rights. This was accomplished in 1947. Soon after the gas unit began functioning, operators started talking about unitizing the oil, too, since it was apparent that effective programs to use and sell gas reserves would be difficult, if not impossible, to achieve without damaging oil recoveries.

The effort to attain the present operation has been pushed hard since.

More than a year was spent in remapping all the oil and gas bearing zones. More than 1,500,000 IBM punch cards were needed just to accumulate the data.

Developing a participation formula satisfactory to operators and royalty interests was a herculean task in view of Seeligson's bewilderingly overlapping pay zones.

And lastly came the formidable, time-consuming drudgery involved in working out the most efficient means of recovering the maximum volume of oil and gas from each reservoir.

Sun's electric analog computer, built specifically to analyze the behavior of oil and gas reservoirs under different recovery programs, played a big role. A companion model, a potentiometric analyzer, was used to help fix water and gas injection points and fluid volumes to be injected and produced.

Nearly 1,500 cores from Seeligson reservoirs were analyzed and a great variety of correlation studies run.

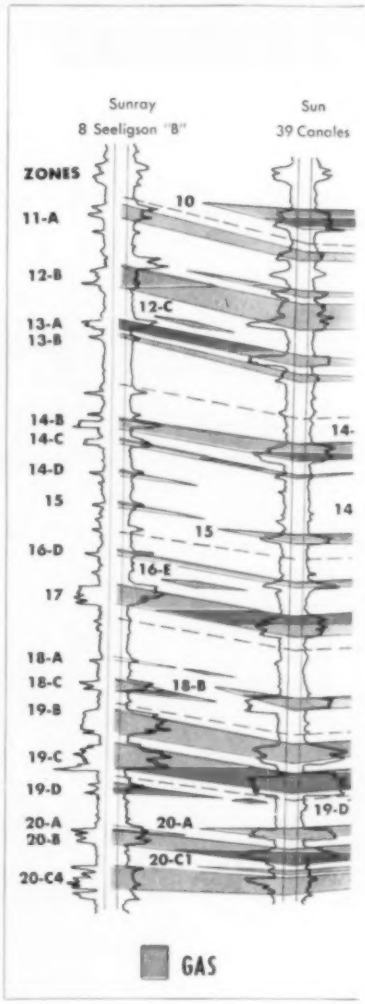
All the work, of course, is not finished. But the unit is at least now on the down-hill run.

The unit setup . . . Sun, as operator, has set up a Seeligson Unit Area, which is charged with carrying out the program and producing the unit. Employes of the company's former Premont, Tex., area were used as the core.

Sun men moving in from other districts and divisions have increased the unit force to 65. George P. Moncrief is area superintendent, and Carl Coil, area engineer.

Roughly 90% of the working interest in the unit is held by five companies: Sun with 30.66%; Sunray Mid-Continent, 25.1%; Magnolia, 14.95%; Shell, 11.4%; and Sinclair, 7.94%.

Magnolia, under the agreement, is continuing to operate the Seeligson gas plant as it did under the old gas unit. The plant is processing and compressing all gas required for pressure maintenance and cycling by the massive recovery project.



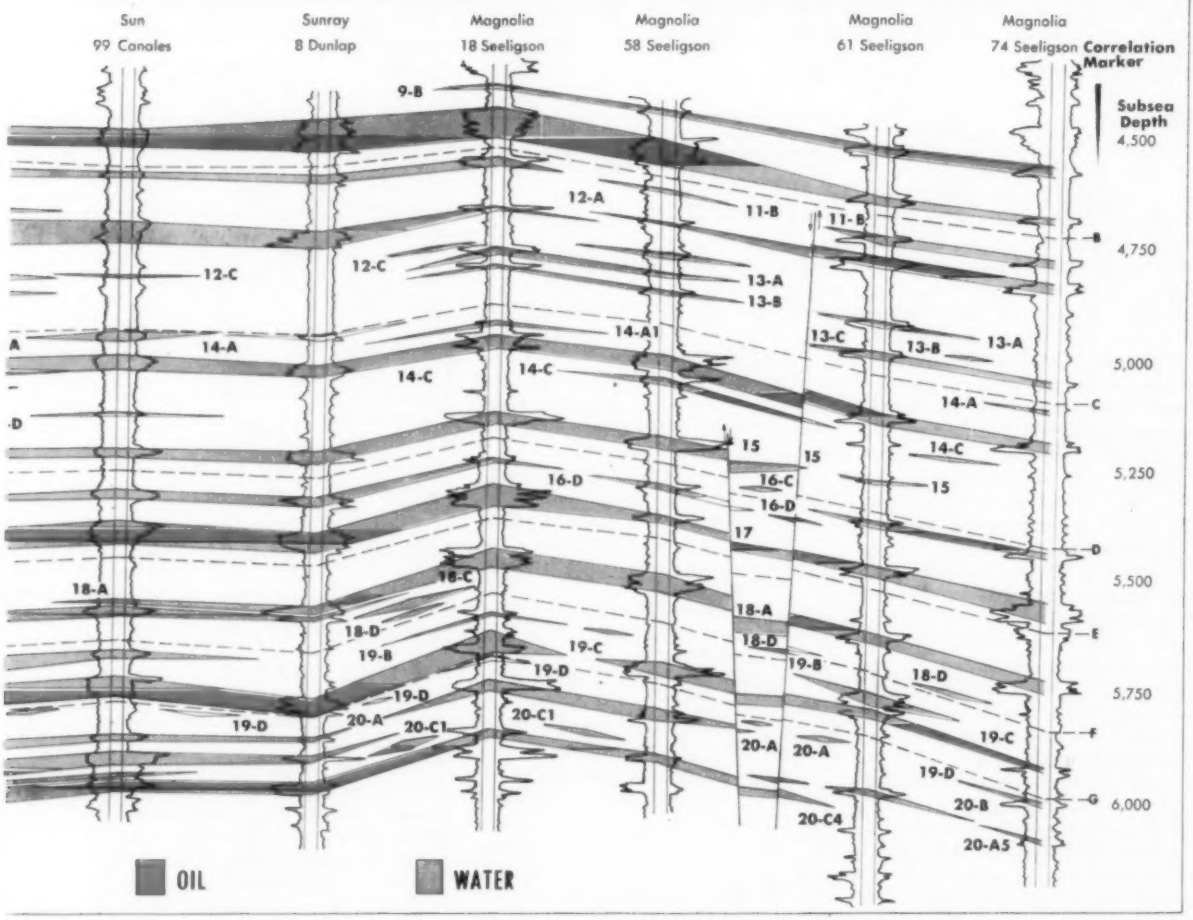
Not all zones discussed below appear in the cross-section above. This cross-section is based on information from seven wells along the crest of the structure, as shown on the adjoining map. Some zones in the unit do not intersect the seven-well line.

ZONE 10—has 38 oil wells, 27 in unit. Only gas injection into cap, plus cycling, planned. Has natural water influx on southern end to keep pressure up. If it should weaken later, water injection may be used to sweep east and southeastern flanks.

ZONE 13A-02—has 22 wells. Has secondary gas cap from extensive pressure loss. Water encroachment irregular. Has produced 23% of oil while losing 60% of its pressure. Water injection planned to bolster irregular natural water drive. If pool pressure boosted enough to overcome free gas saturation, miscible drive may be tried.

ZONE 13A-05—has 7 wells. Unit will cycle gas and salvage oil column.

Cross Section of Seeligson Turns Up Many Sands



ZONE 14-B—has 40 wells, 14 in unit. Gas cap behavior erratic. Gas injection into cap on extreme west side, water into aquifer on southwest, south, north flanks. Cycling planned later. Has produced 20% with 16% pressure loss.

ZONE 16-D—has 58 wells, 54 in unit. Pressure drop critical. Gas will be injected into gas cap, water on southwest, south, north flanks. Has produced 24% of oil in place.

ZONE 17-02—has 2 wells, sizable cap with thin 10-ft. oil rim. Will be cycled and oil column salvaged.

ZONE 17-05—has 25 wells. Has produced 12% of oil, no appreciable pressure loss. Will be cycled and cap controlled.

ZONE 18A-05—has gas cap and thin oil column. Will be cycled and oil column exploited.

ZONE 19B-03—has 102 wells, 26 outside unit. Has produced 21% of its oil, with 24% pressure loss. Injection expected to add 12 to 15%. Will cycle gas cap.

ZONE 19C-04—has 199 wells, 20 outside unit, 3 large gas caps, biggest single pool. Has produced 23% of oil, with 24% pressure loss. Water encroachment fairly regular, but gas coning and irregular gas-cap behavior noted. Will control caps, maintain pressure by injecting gas first into west cap, later into central and northeast caps, plus water on northwest, south, and southeast flanks.

ZONE 19D-01—has 34 wells. Has produced 19% of oil with 40% pressure loss. Water injection in southern area.

ZONE 20A-03—has 16 wells. Gas injection into large gas cap, cap to be cycled, water injection in southeast part of pool.

ZONE 20A-05—has 8 wells, 2 in unit. Gas injection to control cap in northeast, and cap will be cycled.

ZONE 20B-03—has 43 wells, nearly all in unit, 2 gas caps. Gas will be injected into both. Westernmost cap will be cycled. Water injection planned below oil-water contact on south, southwest flanks.

ZONE 20C-02—has 17 oil wells, 9 of them penalized by high gas-oil ratios. Gas injection into cap, plus water injection planned.

ZONE 20C-13—has 1 well. Water injection expected to increase oil take by 15 to 20%.

ZONE 20C-15—has 2 wells. No injection needed now, but plans call for pressure maintenance or cycling, or both.

ZONE 20C-01—has 2 wells. Needs no operating change now. Being considered for miscible program later.

ZONE 20C-44—has 19 wells. Has produced 16% of its oil with a 23% pressure loss. Water and gas injection to control pressure, and cap will be cycled.

Imports Plan Challenged

. . . by Eastern States. Issue may be tied up for months by court action. Dulles and Weeks again back voluntary program as Senate hearings open.

LEGALITY of the oil industry's voluntary import control program may be in doubt for months.

This possibility was raised last week when Eastern States Petroleum & Chemical Corp. challenged the program in the District of Columbia federal court.

The company charged that the program had no basis in law, and illegally had been made mandatory.

Eastern States followed up the filing with a motion for a preliminary injunction against enforcement of the executive order which it contended made the program mandatory. If granted, the injunction will leave the whole report program up in the air while the suit is in the courts.

The case was filed as domestic producers prepared to tell the Senate finance committee this week that a voluntary program is not enough and it should be made mandatory.

Eastern States' move into the courts was not unexpected. The way was paved when it was deprived of a government contract for 12 million barrels of jet fuel on the grounds it had not complied with the program.

But the company first went through the machine for administrative remedy, winding up with a futile appeal to Interior Sec. Fred A. Seaton.

"The failure of the government to adjust Eastern States' quota to reflect Eastern States' contractual import obligations, existing long prior to the establishment of any import control program, makes the action necessary," Chairman R. B. Kahle explained.

"Eastern States has no alternative except to question the program in its entirety," he said.

Eastern States asked the court for an immediate ruling that the program is invalid. It based its plea on four major points:

. . . **There was no proper** delegation of authority for the executive branch to set up the program.

. . . **The program has deprived** the company of property without due process of law.

. . . **The hearing** and other procedures of the Administrative Procedure Act were not adhered to.

. . . **The Buy American Act** was improperly invoked to withhold government contracts. And even if it had been construed to cover the situation, it was misinterpreted.

Eastern States' motion for an immediate finding is not likely to be granted by the court. And the Government is expected to counter with a motion for dismissal of the suit. If that is turned down, the issue may be in the courts for many months.

Dulles, Weeks appear . . . The suit may be used this week as the basis for one last plea by producers for mandatory controls in the Reciprocal Trade Act. Their forum will be the Senate hearings on the House-approved bill.

But the voluntary approach is still strongly defended by the administration. Both Sec. of State John Foster Dulles and Commerce Sec. Sinclair Weeks told the finance committee that the program is working effectively and will be strengthened by the revised national-security clause.

"The President's action on crude-oil imports—and more recently on imports of unfinished gasoline—evidence the fact that the provisions of the statute are available and are invoked when occasion requires," Weeks declared.

A dozen industry witnesses, headed by Gen. Ernest O. Thompson of the Texas Railroad Commission, will argue the cause of stiffer controls, however.

In view of the general feeling that the cards are stacked against quotas, the domestic interests may concentrate on arguments for making the import control program mandatory.

The bill now is not expected to reach the Senate floor until after the middle of July. There will be a period, therefore, in which the trade law will be dead. But the only practical effect of the gap would be to prevent any new reciprocal trade agreements, and none are planned for the immediate future.

Imports During May Increased, But Were Within Allocations

CRUDE-OIL imports jumped sharply in May, reaching an average of 927,600 bbl. daily.

Receipts were 81,400 bbl. daily over the April level of 846,200 bbl. They were under the national allocation of 933,100 bbl. a day, however.

Company reports reaching Capt. M. V. Carson, Jr., import administrator, show that receipts under the District 1-4 program increased from 706,100 bbl. daily in April to 738,200 bbl. daily last month.

Imports under the District 5 program averaged 189,400 bbl. daily last month against 140,100 bbl. a day in April. They were well under the allowable of 220,100 bbl. daily, although a half-dozen importers exceeded their quotas for the month.

Receipts under both programs were less than originally scheduled by importers. Estimates submitted to Carson 3 months ago placed June receipts under the District 1-4 program at 845,500 bbl. daily and under the District 5 program at 206,400 bbl. daily.

Humble Slows Up

on offshore operations. Only two rigs are drilling in gulf.

HUMBLE Oil & Refining Co. has mothballed practically its entire offshore drilling fleet because of adverse economic conditions.

Last week Humble had only two drilling rigs operating in the Gulf of Mexico. At one time the company had as many as 21 rigs at work there.

Ten Humble drilling tenders are included in the shutdown equipment. They are in mothballs at Orange, Tex. Indications are they will remain there until the economics of offshore operations become more favorable.

Once the most active drilling company in the gulf, Humble has been cutting back its operations gradually for many months. During 1957, though, it had an average of about 16 rigs working in the gulf at all times.

During the peak of offshore operation Humble had several rigs operating on self-contained platforms in addition to those working with the company's own tenders.

Humble's two active offshore rigs were on location last week in Block 16 field off Grand Isle and Block 54 field in the South Timbalier area, both off Louisiana. The company has enough offshore drilling scheduled for remainder of this year to keep these rigs busy.

Humble's decision to reduce its offshore exploration and development program is said to be a result of cutbacks in production allowables.

Hancock Sale Off

as Jersey becomes fourth oil firm to turn down the deal. Asking price too high.

STANDARD OIL CO. (N. J.) has dropped plans to buy Hancock Oil Co., the West Coast firm recently hit by a fire at its Long Beach refinery.

A brief statement issued last week by "controlling stockholders" of Hancock revealed Jersey Standard is backing away from the deal.

The Hancock statement read:

"The controlling stockholders were informed by the major oil company with whom they have been carrying on discussions that it has decided not to make an offer, and that it was terminating discussions."

The "controlling stockholders" were not identified. However, a major Hancock stockholder is Mrs. Will J. Reid, a member of a pioneer Long Beach family. Mrs. Reid has been negotiating with Jersey Standard through Charles R. Gaylord, a Hancock director and Long Beach attorney.

No reason was given for Jersey's cutting off negotiations, but it was reported the asking price was too high. It was reported Hancock wanted 1¼ shares of Jersey stock for each share of Hancock stock. This would have placed Hancock's value at about $220 million.

The high asking price reportedly discouraged three other companies which earlier had looked at Hancock. Sinclair, Continental, and American Petrofina have all turned down deals with Hancock.

Hancock's stock took a big jump during the 2 months Jersey was negotiating with the company. When word leaked out that the negotiations were on, Hancock stock was listed at about 27½. During the negotiations, it went as high as 56⅜. The night before Hancock's statement that the deal is off, it closed at 54. The next morning it dropped 9½ points to 44½.

The fire . . . It is doubtful that the fire which damaged Hancock's 22,000-bbl. Long Beach refinery late in May had any bearing on whether Jersey continued negotiations. All damage caused by the fire was covered by insurance (OGJ, June 2, p. 80).

The fire caused damage estimated at $8 million. About 8,000 home owners have filed claims against Hancock totaling between $2,500,000 and $3,000,000. This is about half what had been expected by insurance adjustors.

watching WASHINGTON

. . . with Bertram F. Linz

• Bills await wastebasket treatment

CONGRESS is on the last lap of its 1958 session. From now on work will speed up as members looking toward reelection seek to end the term in mid-August so they can get home to campaign.

Senate and House committees are starting their annual housecleaning, tossing out all bills not of major importance. This year, what is tossed out will go into the wastebasket because 1959 will bring a brand-new Congress.

Several bills of some interest to the oil industry are expected to be lost in the shuffle. Fair-trade bills permitting manufacturers to fix retail prices, bills to overturn the Supreme Court's good-faith defense ruling, and new antimerger legislation have little chance of passage this year.

The measure most important to a big segment of the industry—the Harris-O'Hara gas bill—died on the vine months ago.

The remaining big business of the session, so far as oil is concerned, lies in three bills now in the works—taxes, import control, and Alaskan statehood. One other bill might come up, with good chance of passage if it does, turning San Nicolas and two other islands off California into a new naval oil reserve.

• Government gets practical about figures

OIL MEN who use government figures to backstop their guesses on the state of business will get much more reliable information soon.

Congress has finally come up with the money needed to put basic data on a practical level. This is one of the few good byproducts of the recession.

Take the figures on gross national product, for instance. In the past they made no allowance for price changes. So last year the GNP reports showed that business was booming, but didn't show that prices were rising much faster than output. Critics say that had they been adjusted for price changes businessmen would have seen much earlier that the boom was over.

Future reports will be better signposts of where the economy has been and where it is going. And to make the picture complete, the GNP figures will be revised over the past 10 years.

• Senate gears for depletion fight

THE 1958 FIGHT over depletion has been scheduled. It will be held on the Senate floor, probably next month.

Sen. William Proxmire (D-Wis.) will head an antioil bloc demanding that the rate for oil, gas, and some minerals be cut to 15%.

Proxmire charges that the present 27½% rate is a "gigantic giveaway." A few large corporations reap 90% of the benefit, and it gives the "big boys" political power, he contends.

A cut in the rate to 15% would give the Treasury another $325 to $500 million a year, Proxmire asserts.

The administration and Capitol leaders are opposed to any tinkering with depletion. They are confident the move can be licked.

But if the depletion question is brought up, it will offer an opportunity for other groups to make a pitch for changes in the law.

Sens. Joseph C. O'Mahoney (D-Wyo.) and John A. Carroll (D-Colo.) may move to limit depletion to U. S. production—an outgrowth of last year's probe into the relations of Arabian American Oil Co. and the Saudi Government. And Sen. Gordon Allott (R-Colo.) may press for a 27½% allowance for oil shale.

IOCC Study Says U. S. Can Recover 43.7 Billion Barrels

(Millions of barrels)

State—	Original Oil in Place	Production to 1-1-58	1957 Production (API)	Proved Reserves (API)	% Proved Reserves Produced in 1957	Proved Primary Reserves (IOCC) 1-1-58	Reserves Recoverable by Known Injection Techniques	Reserves Recoverable by Injection Under Economic Conditions 1-1-58
New York	743	202	3	38	7.1	0	63	52
Pennsylvania	3,831	1,203	8	126	6.5	29	771	126
West Virginia	2,585	458	2	53	4.2	49	594	60
Kentucky	1,450	352	17	138	12.5	140	450	65
Ohio	4,500	649	6	68	8.1	65	185	7
Indiana	3,000	281	12	67	17.7	66	265	65
Illinois	7,211	1,996	76	655	11.6	356	3,250	1,200
Michigan	1,423	406	10	49	20.8	51	290	95
North Dakota	2,699	50	13	258	5.0	649	757	110
Nebraska	1,030	75	20	63	31.1	80	80	50
Kansas	14,700	2,959	124	948	13.0	850	325	100
Oklahoma	47,035	7,627	211	1,942	10.9	1,510	1,416	566
Arkansas	4,147	996	30	305	9.7	149	1,270	1,100
Alabama	358	18	6	34	18.7	58	118	98
Mississippi	3,107	546	37	360	10.3	407	1,032	86
Louisiana	22,423	4,333	298	3,858	7.7	4,051	5,070	2,282
Texas	105,357	21,058	1,057	14,555	7.2	15,201	10,236	4,856
New Mexico	8,000	1,178	92	832	11.1	1,094	2,288	500
Colorado	3,106	456	55	310	17.7	282	887	610
Wyoming	10,511	1,542	110	1,420	7.7	1,234	1,133	403
Montana	2,686	276	27	320	8.4	346	155	62
Utah	380	18	5	140	3.3	140	76	28
California	59,560	11,130	339	3,760	9.0	3,760	3,770	573
Other states	65	9	1	4	13.2	4	2	1
TOTAL	**309,907**	**57,818**	**2,559**	**30,300**	**8.4**	**30,580**	**34,483**	**13,095**
Increase from 1-1-56	21,384	5,131	140*	288		910	1,653	1,116

*Increase from 1955 to 1957 production.

Fluid Injection Means More Reserves

SOME authorities believe the oil industry should change its definition of crude reserves and think in terms of the total crude which can be produced economically by present methods.

Such an approach would put the reserve figure considerably higher than the one generally accepted.

This has been done by the Interstate Oil Compact Commission, which has come up with a reserve figure of 43-plus billion barrels.

A report on the latest study was presented last week by Paul Torrey, chairman of the compact's secondary-recovery committee.

Torrey's estimate includes all reserves recoverable by presently known fluid-injection techniques—under today's economics.

The American Petroleum Institute, which sets reserves at 30 billion barrels, includes secondary reserves only in fields where fluid injection has been started.

Torrey's figures show an increase in reserves of about 2 billion barrels since the same committee made a similar study 2 years ago. His current study shows:

. . . **Proved primary reserves** in the U. S. total 30.6 billion barrels as of January 1, 1958, a gain of .9 billion from January 1, 1956.

. . . **Reserves** which can be recovered profitably by fluid injection total 13.1 billion, up 1.1 billion from 2 years ago.

. . . **These two figures** add up to well over 43 billion barrels and spotlight the importance of considering potential secondary recovery in calculating future U. S. production.

Could be more . . . The Torrey committee makes a further important point.

While the statistics show that fluid injection can produce 13.1 billion barrels of oil profitably, the potential recovery actually is 34.5 billion.

While Torrey doesn't say it directly, the conclusion may be drawn that higher prices for crude will result in

greater recovery by fluid injection.

"There must be," he says, "adequate incentive provided to encourage the widespread utilization of these marvelous new inventions and processes."

He makes a special plea to keep "precious" stripper production going full force.

Difference in figures . . . Torrey's figures also differ with the API's on proved reserves (see table). But he does not see this as a matter for serious dispute.

The API estimate places proved reserves, including those in fields where fluid injection is being applied, at 30.3 billion barrels. Torrey estimates proved primary reserves—with no fluid injection reserves included—at 30.6 billion.

"This is a matter of opinion," he said, "and certainly need not be cause for contention, for it is well known that the API Reserves Committee periodically has revised and increased its estimations of proved reserves as new fields have been discovered, as the area of known fields has been expanded, or as deeper reservoirs have been found in older fields."

Torrey obtained his reserve estimates, for the most part, from leading authorities selected by governors of the oil-producing states for the IOCC.

"The information they have developed can be accepted as the most reliable that can be obtained," he says.

"Challenge" to the industry . . . Carrying through the compact's emphasis on secondary recovery, Torrey cites figures from the study showing the "challenging problem" of recovering more oil from known reserves.

His study estimates original oil in place in the U. S. at 309.9 billion barrels. Production to January 1 of this year was 57.8 billion. This production, coupled with estimated future production by profitable fluid injection techniques, runs the total to 101.5 billion. This is just 32.8% of the original oil in place.

This percentage of recovery is considerably better than that obtained a few decades ago because of conservation practices and the invention of new production techniques, Torrey says.

"Nevertheless," he concludes, "the some 208 billion barrels that will not be recovered under existing conditions presents a challenging problem from the standpoint of the tremendous energy potential involved, for the security of the nation, and because the production of oil contributes so much to the maintenance of government and to the comfort and welfare of the people."

Smackover Has Pollution Blight

LOUISIANA is putting the pressure on Arkansas to halt oil-well pollution of the Ouachita River.

There's no dispute that Ouachita basin waters have been polluted, not only by oil and gas wells in Smackover and other fields, but by cities and industrial plants in the area.

There's agreement, too, that something should be done about it. Last week representatives of the two states were in disagreement over how soon it should be done.

At issue is a 5-year plan of pollution abatement advanced by the Arkansas Oil Association.

Monroe, La., which wants to use Ouachita water for municipal purposes, feels 5 years is much too long to wait for good water. Smackover operators, on the other hand, say that to try to solve the problem sooner would slash their oil production.

Last week the Arkansas Water Pollution Control Commission held two public hearings on the issue at El Dorado and took the matter under advisement.

William F. Piper, a city attorney for Monroe, told the hearing that Monroe expects to grow in population from 47,000 in 1956 to 55,000 in 1960 and that it must draw water from the Ouachita.

Robert E. Adair, president of the Arkansas Oil Association, said the 5-year plan to halt pollution is the best that oil operators could devise without giving up their production.

Adair said the 114 members of the association are producing 16,466 bbl. per day from 1,737 wells in the stripper areas in and near the 35-year-old Smackover field. They also produce and dispose of 307,620 bbl. daily of salt water, a prime source of pollution.

Each operator, he said, is working on a program to reduce the amount of salt water going into Ouachita tributaries by 20% the first year.

One producer testified that he has 33 wells on 10 leases producing a total of 491 bbl. daily of crude, plus salt water. If he stopped producing salt water immediately, his total crude production would drop to 65 bbl. daily.

Good-Faith Bill Looks Dead

THE SKELETON of a once-robust bill to overturn the Supreme Court's "good faith" decision in the so-called Detroit case of Standard Oil Co. (Ind.) went to the Senate floor last week.

As it came out of the judiciary committee the measure would have no effect on the oil industry. It would be limited to processed food, drugs, and cosmetics—a sop to the industries which have most actively worked for its passage.

Sen. Estes Kefauver (D-Tenn.), who wrote the bill, will make a valiant fight on the floor to broaden it. But it is a question whether he has any solid support from senators who over the past few years have become sick of the issue.

The Supreme Court held in 1951 that the cutting of prices to selected customers to meet competition in good faith did not violate the antiprice discrimination clauses of the Robinson-Patman Act.

Bills to overturn that decision have been brought up in Congress annually.

The high court again ruled on the issue last January. It restated its first opinion that Indiana Standard acted legally in granting a price reduction to four Detroit-area jobbers who also owned filling stations. Competitors had been trying to take the business away (OGJ, Feb. 3, p. 70).

The Kefauver bill and a similar measure written by Rep. Wright Patman (D-Tex.) were introduced in January 1957, and have been bottled up in committee for the past 17 months.

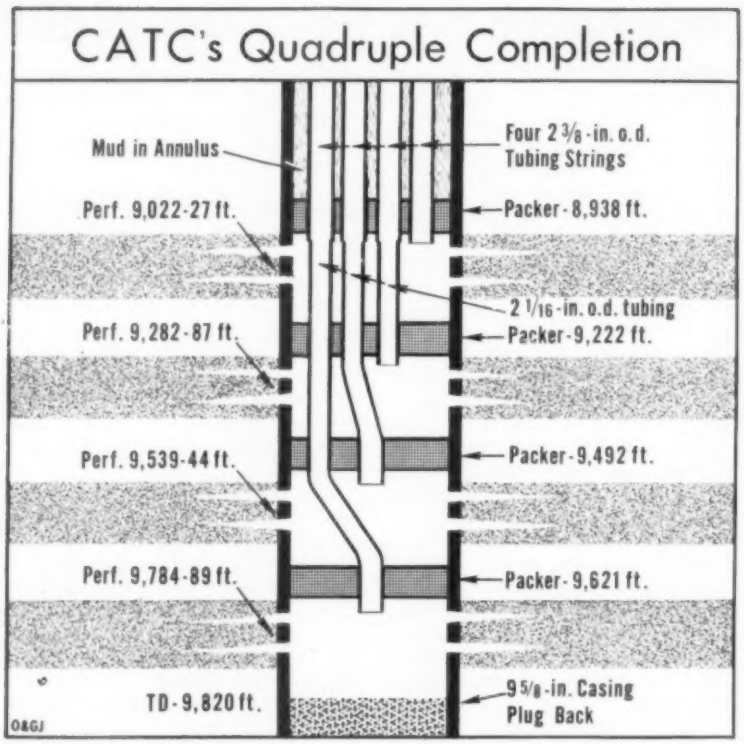
The oil industry is opposed to a bill of any kind, fearing that if even the bobtailed version of the Kefauver measure is passed it might be broadened later to include oil.

There is a chance the Senate will accept the Kefauver bill. It might even amend it at his insistence. But there is little chance the measure will reach the House floor this session.

Drive for fair trade . . . With the good-faith measure practically at the end of its rope, retailing interests, chiefly the druggists, are turning to bills setting up a national fair-trade law.

Bills now in Congress would make fair trade a national practice. They would permit manufacturers of branded goods to set the prices for sale at retail, and violation would be a federal offense.

These measures, however, also are given little chance of passage this year.



A Four-Stringer—First Ever

CATC OFFSHORE GROUP has completed a well which flows oil from four separate sands out of four separate tubing strings. The well is the world's first such four-string quadruple.

Continental Oil Co., operator for CATC, reports that packers and tubing for the quadruple were run without great difficulty and without undue loss of time. Pressure tests showed no communication between zones.

The history-making well is on a platform 10 miles off Louisiana's Southwest Pass at the mouth of the Mississippi River. It is the eighth to be drilled from a self-contained platform in West Delta Block 30 field. The field was discovered in 1949, and it now includes 27 wells.

The CATC group is composed of Continental, Atlantic Refining Co., Tidewater Oil Co., and Cities Service Production Co.

Multiple completions have been mushrooming in popularity in recent months offshore. They represent one way operators can partially offset the effects of today's low allowables. The conflict of low allowables and high drilling costs has been a prime reason that some operators have almost completely abandoned their offshore drilling programs (see related story p. 44).

Mud in the annulus . . . CATC's well, while the first to produce from four individual tubing strings, is not the first to product from four zones simultaneously.

That honor was taken 4 months ago by Magnolia Petroleum Co. (OGJ, March 3, p. 81). Magnolia completed its 8 Santa Cruz Farms in Hidalgo County, Texas, in four gas zones—three flowing from individual tubing strings and one flowing out the annulus. This meant that, in down-hole equipment, the Magnolia well was like a conventional triple completion except that there was a fourth zone perforated above the top packer.

CATC is not permitted to make such a qaudruple. Offshore operating regulations require that the casing-tubing annulus be filled with mud to

Texas Commission Approves Triple-Zone

A NEW Texas Railroad Commission policy allowing oil production from more than two zones may open the door to reexamination of old adverse orders involving the same issue.

The commission has suddenly and surprisingly reversed what had been regarded generally as a rock-hard policy against such multiple production.

The members approved without comment an application by David and Inez G. Fasken to complete their 2 Fee "J" to produce from three separate oil reservoirs in the Fasken fields area of Andrews County, West Texas.

The 2 Fee "J" will produce through three strings of tubing from the Fasken Wolfcamp at 8,436 to 8,672 ft., the South Andrews Devonian at 10,930 to 11,032 ft., and the Fasken Ellenburger at 12,585 to 12,626 ft.

The action came as a surprise in that the commission only a few months back was declining even to accept for hearing applications to install triple oil completions.

Though no reason for the quick switch was offered, commission sources say the agency concedes that it is setting a precedent and changing policy by approving the Fasken triple.

And there are hints that similar applications turned down in the past might now be reexamined and possibly approved if refiled.

Operators applaud . . . Producers generally hail the commission order as a big step forward.

In recent months, many producers have pushed hard at technical and other industry meetings for quick acceptance of technical advances in production techniques so as to lower unit costs of producing the domestic barrel of oil.

Reluctance overcome . . . The commission, as a body, has refused to permit triple oil completions in the past primarily for two reasons. It felt that:

. . . **Enforcement** would be difficult.

. . . **Oil might be left** behind that would be recovered if other oil zones weren't in the picture.

Sources close to the commission say its members gradually have become convinced that a well producing from three zones wouldn't be much harder to police than one producing from two pays.

The Fasken well . . . The precedent-setting Fasken triple completion is equipped with a Baker Model D triple-string flow tube.

Each of the three pays will flow

protect the well from damage by hurricanes or collision by ships. For that reason, there must be a separate tubing string for every completion zone in any offshore well.

And, since practical wellheads and packers for parallel strings have been perfected in recent years, concentric-string multiple completions have virtually disappeared.

Casing and strings . . . The new quadruple well, CATC's State 970 No. 8, is cased with 9⅝-in. pipe to a plug-back depth of 9,820 ft.

Perforations for production are at 9,784-89; 9,539-44; 9,282-87; and 9,022-27 ft. The first tubing string run into the well carried four Brown Oil Tool HS hydraulic-type packers. These were set by pressure at 9,621; 9,492; 9,222; and 8,938 ft.

The remaining three strings, run one at a time, carried no packers. All four of the tubing strings are 2⅜-in. Hydril SC above the top packer. Between packers the strings are made up of 2⅛-in. Hydril CS tubing. There are no landing nipples or side-door-choke nipples in the strings. Since all strings are full opening through the packers, bottom-hole-pressure bombs and other wire-line tools can be run opposite each sand face.

After the packers were set and the tubing strings in place, the christmas tree was installed. Each zone was brought into production by swabbing through the tree. On tests through 8/64-in. chokes, the four zones made more than 1,100 bbl. per day of 26° to 32°-gravity oil and 540,000 cu. ft. of gas.

Completion

through its own 2⅜-in. o.d. string of tubing. The annulus will be loaded with oil above the top packer.

Total potential from the 12,626-ft. well was about 928 bbl. daily.

The Wolfcamp, on a 17-hour potential test through a 20/64-in. choke, flowed 226 bbl. of 44°-gravity oil with a 40% water cut. Gas-oil ratio was 1,586:1 and flowing tubing pressure 750 psi. The Devonian horizon flowed 293 bbl. of 46°-gravity oil through a 20/64-in. choke in 24 hours with a GOR of 1,768:1 and flowing tubing pressure of 258 psi. The Ellenburger, the most prolific, tested 409 bbl. of 52°-gravity crude in 24 hours through a 13/64-in. choke. GOR was 612:1 and flowing tubing pressure 840 psi.

The well is located in Section 5, Block 42, G&MMB&A Survey, T-2-N.

Alberta Demand Jumps in July

DEMAND for Alberta crude, which rolled steadily downhill this spring, will take a healthy spurt in July.

Purchasers plan to use 335,395 bbl. daily. This is 60,129 bbl. greater than the June demand, and the highest level since last February.

The big increase is due strictly to Canadian demand. U. S. nominations are actually down 800 bbl. daily, for a total of 43,700 bbl. And U. S. requests will likely drop another notch later this summer.

Shell Oil Co.'s Anacortes, Wash., refinery, one of the better export markets for Alberta crude, will not take any Alberta oil during August and September. However, the company's July nomination was 19,400 bbl.

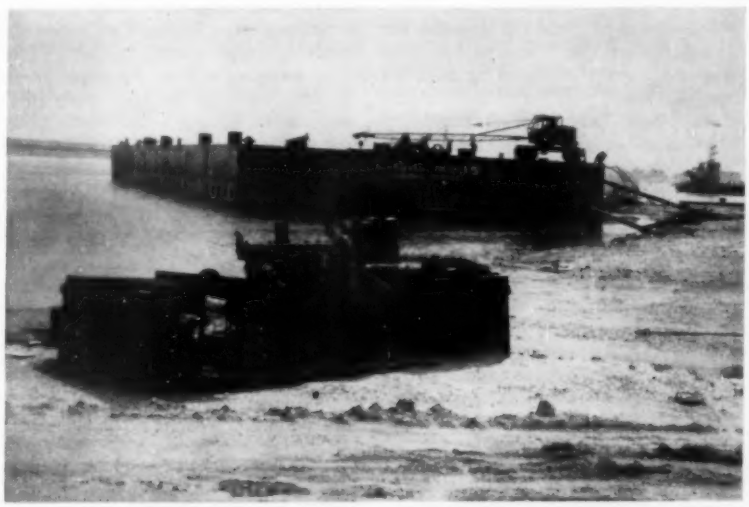
Shell officials explained the decision was based strictly on economic factors: The company cannot afford to use Alberta crude and compete with other refiners processing cheaper foreign crude.

Imperial hikes bid . . . Much of the credit for the improved market demand goes to Imperial Oil, Ltd.

Imperial will use 144,100 bbl. daily in July, which is 51,650 bbl. higher than that company's June request.

All Canadian provinces, except Manitoba, will take more crude in July. British Columbia refiners want 65,042 bbl. daily—28,643 bbl. more than last month.

In addition to Shell's Anacortes nomination, other U. S. requests include General Petroleum Corp., Ferndale, Wash., 11,500 bbl. daily; International Refineries, Inc., Wrenshall, Minn., 6,100 bbl.; Lake Superior Refining Co., Superior, Wis., 3,900 bbl.; and Bay Refining Corp., Bay City, Mich., 2,800 bbl.



SALVAGED HULL of famous platform is reconditioned and . . .

"Mr. Gus I" May Drill Again

THE ILL-FATED "Mr. Gus I" is being partially resurrected and is due to drill again one of these days.

The bottom hull of the big offshore drilling platform, which foundered off the South Texas coast last year, has been put back into practically new condition by its owner, C. G. Glasscock Drilling Co.

The hull, now listed as C.G.G. Barge No. 15, may be outfitted for shallow bay drilling with a rig aboard, or as a tender for possible service in Venezuela.

No definite decision has been made yet. Time of the new assignment will depend on the outlook for the drilling business in the months ahead.

The $3,500,000 mobile unit capsized in 40 ft. of water last year (OGJ, Apr. 8, 1957, p. 66). The costly salvage job started soon after, but it was delayed repeatedly by rough water (OGJ, Sept. 2, 1957, p. 85).

Much of the drilling equipment which will go on the reconditioned barge was salvaged, including mud pumps and large diesel engines.

Slim, New Gun Works Below Tubing

• It's a simple, fixed-jet perforator designed for multiple completions. It will slip through 1½-in. tubing to perforate large casing down the hole. Bulky primacord is eliminated by Schlumberger by means of a chain firing system.

GOOD PENETRATION of large-diameter casing below 1½-in. tubing is the promise of a new fixed-jet perforator.

To pass through 1½-in. tubing, outside diameter of the perforator has been whittled down to 1⅜ in. To reliably perforate large casing below the tubing, these new features have been added:

. . . A magnetic orienting device which fixes gun clearance in the casing, thus insuring good penetration by all jet charges.

. . . A "chain-firing" system that eliminates conventional primacord.

The new 1⅜-in. "Chain Jet Expendable Gun" was developed by Schlumberger Well Surveying Corp. It's designed to meet the demand for a tool slim enough to run in the small diameter strings common to multiple completions.

The new perforator has already been used at least 15 times in the field, shooting both upper and lower zones of dual completions.

A rapidly growing number of multiple completions produce through 1½-in. tubing. And, until now, the only gun available to perforate casing below this tubing has been a "swing-jet" model.

However, Schlumberger felt a fixed-jet gun should avoid some of the mechanical troubles that can arise when using a perforator with moving parts. The fixed-jet design is inherently simple and rugged.

Eliminating long shots . . . Any perforating gun ordinarily hangs along the low side of the hole, not in the center.

Because of this, jets often have to fire from one side of the hole completely across the hole to the other side. This is not a special problem with large-diameter guns which have little clearance with the casing.

However, the "long shots" across the diameter of the casing are a big problem with small-diameter guns which have a lot of clearance. On these long shots both the hole size and penetration depth are reduced.

Schlumberger chose to beat the problem by preventing the long shots. The solution was to put a magnetic aligning tool into the gun. Permanent magnets in the gun's retrievable housing attract themselves to the pipe wall and hold the gun there.

Because the magnet's magnetic axis is always the same in the gun, the same side of the gun is always held to the casing. Jets are set 90° to each side of this magnetic axis (see drawing). Thus, they are always aligned with the same small clearance with the casing, insuring good penetration.

Eliminating the primacord . . . Until the chain jet was introduced, all jet perforators used primacord to detonate each jet in succession.

The primacord does its job well. But it takes up space, and there's precious little space for primacord in a fixed-jet gun only 1⅜ in. in diameter. To beat the space problem, Schlumberger devised a new firing system which uses no primacord (drawing).

The jets are set at a 30° angle to the horizontal. Thus, horizontal penetration of the jet is about 0.866 times the actual penetration depth.

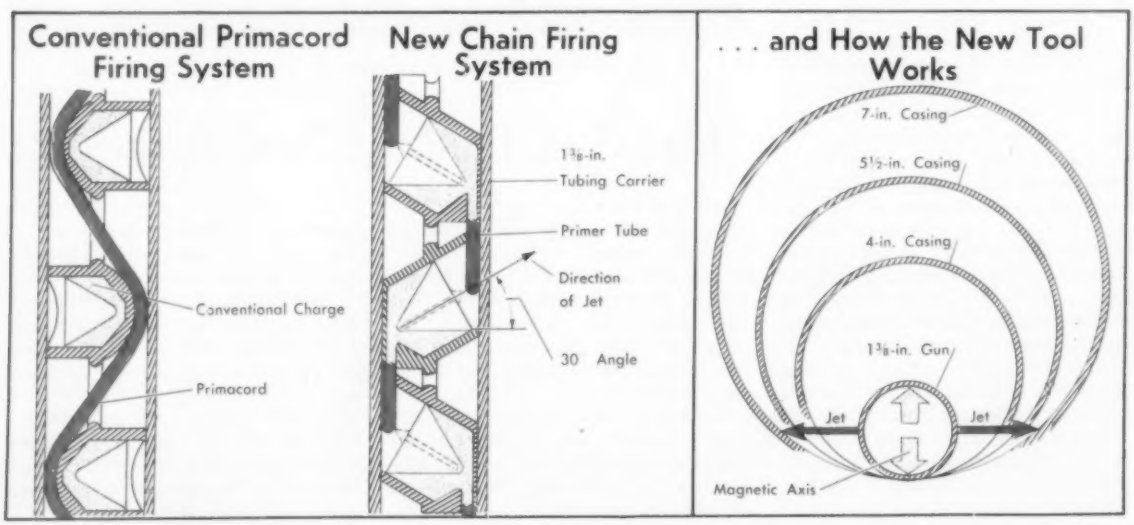
Tests of the chain jets show that penetration, actual and horizontal, is good. And, production flow index averages about 1.05—good for any perforating tool.

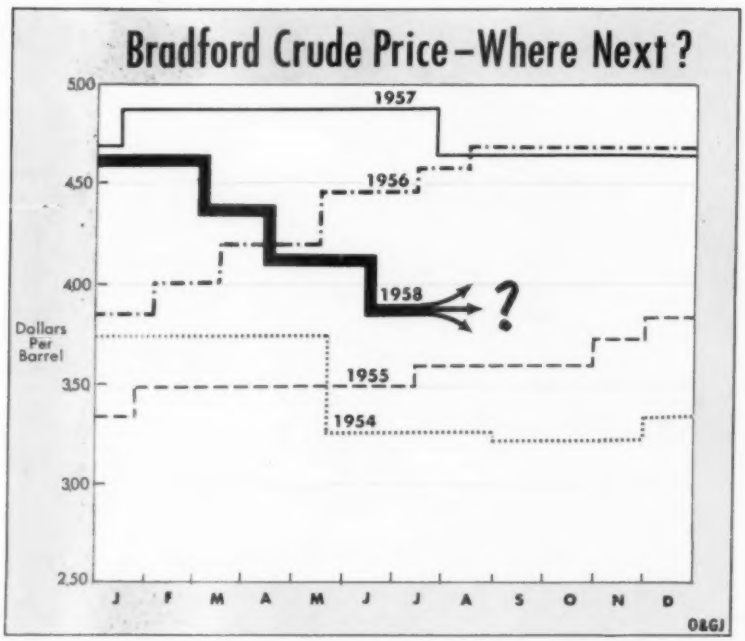
Carrier is expendable . . . The aluminum carrier on the chain-jet gun breaks up into small pieces when the gun is fired.

There is about 0.9 lb. of debris left in the hole for each foot of gun fired. This occupies only a small volume in the hole—about ⅜ in. in 5½-in. casing.

Schlumberger points out that should the firing system fail in the hole, all unfired jets will be brought to the surface. Thus, there would be no doubt as to the number and depth of shots made.

The chain-jet gun is presently rated for downhole pressure and temperature of 6,000 psi. and 300° F.





Penn Grade in Trouble Again

PRODUCERS, refiners, and marketers of Pennsylvania Grade crude oil and its products are in a tough spot again. But, with a confidence based on having survived similar troubled periods in the past, they are looking to the future with a degree of optimism.

This year's 15% drop in domestic lube-oil demand and a drop of more than 17% in export demand have hit the Pennsylvania Grade companies hard. Their finished lube stocks are 20% higher than they were a year ago, and runs have been cut from around 41,000 bbl. per day to less than 35,000 bbl. These blows have been compounded by the loss of outlets.

In mid-June Sinclair Refining Co. closed its refinery at Wellsville, N. Y. Earlier United Refining Co. stopped running Pennsylvania crude at its Warren, Pa., refinery. Between them they had been processing 3,000 to 4,000 bbl. per day. That's about 10% of what Penn Grade runs to stills have been averaging in recent weeks. Combined, the drop in demand and the loss of outlets have lopped about 25% of the demand for Pennsylvania Grade crude.

These were the problems facing members of the Pennsylvania Grade Crude Oil Association at its thirty-fifth annual meeting in Bradford. A panel of experts analyzed the situation, which J. P. Jones, Bradford producer and president of the association, described as the "most troubled" in his experience.

Price problem . . . All the experts spoke of the area's high costs due to low volume. But there was another problem scored by the producer and jobber representatives: Price instability.

K. R. Cochran, vice president, Bradley Producing Corp., said the price of crude has changed 17 times since the beginning of 1954 (see chart). Ranging from $3.23 to $4.88, the unstable price makes sound investment in production impossible.

R. D. Lowe, vice president, Elk Refining Co., said that Pennsylvania bright stock has ranged in price from 10 cents to 45 and 50 cents per gallon in the past 10 years. There is no security for jobbers in handling Pennsylvania oils, he said.

Not all bad . . . While there was plenty to discourage them, the members heard several cheering statements:

. . . Reserves of Pennsylvania Grade crude, in relation to demand, are one-third higher than for the country as a whole. Thus, there is good reason to believe the Pennsylvania operator will be in business for long time to come.

. . . Pennsylvania Grade crude contains a much higher percentage and quality of lubricating oil than any other crude and will continue to bring a higher price than other crudes.

. . . Loss of refinery outlets will tend to concentrate more finished oil in branded products. This should contribute to the much-desired stability.

The cutback in runs has sharply curtailed producing operations, and a number of development projects have been suspended or delayed. Producers, however, are improving recoveries and testing methods to increase recoveries still more. Methods include miscible-phase displacement, fracturing, and in situ combustion.

OCAW May Merge

with chemical union. Talks will be held during August.

THE OIL, CHEMICAL, and Atomic Workers International Union is making a renewed effort to merge with the International Chemical Workers Union.

OCAW Pres. O. A. Knight has written ICWU Pres. Walter Mitchell proposing that committees representing the two unions meet in August to explore the possibilities of affiliation.

Knight suggested the powwow be held the week of August 17 in Forest Park, Pa. If this date and place are not acceptable, Knight proposed that the meeting be held the week of August 10 in Chicago, Cleveland, or Akron.

"We believe that a meeting of this sort can do much of the preliminary work and can initiate the development of a positive program which could then be submitted to each union for consideration," Knight wrote.

The 210,000-member OCAW would be the surviving union in event of a merger. ICWU membership is approximately half that of Knight's group.

World plan studied . . . The International Federation of Petroleum Workers, also headed by Knight, is studying a merger with the Chemical Workers Trade Secretariat, under the presidency of James Matthews of England.

Subcommittees of the two unions will meet later this year to try to iron out differences and recommend an operating structure. If the merger is accomplished, the resulting organization would represent about 2,000,000 members in the chemical and petrochemical industries throughout the world. The 4-year-old IFPW has affiliates in 28 countries. The 50-year-old CWTS operates in 13 countries.

RUGGED Four Corners area gave birth to an unusual airline. Now . . .

Commuters Fly to Work in Aneth Area

Carl Hoot
Tulsa District Editor

FOUR CORNERS Pipe Line Co. is winning the transportation battle in the rugged Four Corners area with airplanes.

In this desert country where rocky gorges force long detours in the sparse and bumpy roads, getting men and their equipment to work and back has been a long, tiring, and expensive job.

Trucks and cars are worn out after only 10,000 miles in the rough and rocky terrain. Workmen usually must spend 7 hours on the road to make a round trip from their homes in Farmington to their jobs in the field.

To save money, speed up movement of men to their jobs, and to permit employes to live with their families in Farmington rather than in distant field camps, Four Corners Pipe Line has set up an unusual airline.

It's a commuter service which operates on an airline schedule. It is leased entirely—pilots, planes, and maintenance—but it operates under direction of the pipeline management.

It's strictly a working airline, with its passenger list made up entirely of gagers, mechanics, and maintenance men. Company officials need not apply to fly; they're not eligible.

Logical answer . . . The airline seemed the only good solution to Four Corners Pipe Line's transportation problem.

The company operates in the arid country where the states of Utah, Colorado, Arizona, and New Mexico join. By auto, it's 3½ bumpy hours from Farmington to Aneth and other oil fields in the area. Planes make the distance in only 30 minutes.

With ground travel so expensive and time consuming, the airplane became economically attractive. The question for Four Corners management then became simply whether to buy and staff the planes, charter them, or take a lease plan.

Gleason Romans, airplane pipeline patrol operator, showed the company how he could furnish the planes, hangar facilities, service, and pilots on a lease basis cheaper than Four Corners could buy and operate them. His offer also carried the provision that scheduling and operation of the planes would be under Four Corners' control.

Weeks of study and trial-run operations preceded start up of this service to personnel working in the fields. Since weather was expected to be a hazard, records for 20 years were dug up and analyzed. A number of aircraft types were considered, and the passenger volume estimated.

How it works . . . The final decision was to use two standard Cessna 182 model planes with larger wheels and heavier landing gear.

The ships are regular four-passenger craft, including pilot.

Radio equipment is standard with extra bands to tie in with company's field and office communications system.

Factors involved in choosing the equipment were the limited number of men to be transported at a time, the light tools carried by the men to their work, and ability to land and takeoff on short field strips.

Four Corners also instituted one operating policy unique in the industry: No company brass rides the planes.

EMPLOYES catch the 7 a.m. at Farmington and . . .

ARRIVE at Aneth air strip only 30 minutes later.

District Superintendent Charlie Merrill declared "the lowest gager has highest priority on this airline—we want the men on the job and on time, which is our main reason for the airlift."

Morning flights to the fields start promptly at 7 a.m. from Farmington airport. With 30 minutes required to cover the 75 air miles, the planes are back for a second lift starting at 8 a.m.

Evening tour men leave Farmington airport starting at 4 p.m., and the planes returning from these trips bring back those who went out that morning for the day shift.

Men like the ride . . . Four Corners' personnel are under no obligation to ride the airlift.

There is no cost to them, however, for this service which permits them to avoid the 3½-hour gruelling ride to work in personal transportation. Besides, the advantage of living in Farmington rather than in a field camp appeals to the men and their families.

Pilots of the line reported a few nervous passengers on some of the first runs. The nervous ones were encouraged to ride up front with the pilot and were allowed to help fly the plane which dispelled their fears. After only a few trips their uneasiness vanished, and these men started looking forward to the ride.

The lease plan . . . Leased aircraft is common practice in the oil business generally.

But the Four Corners' operation has a few unusual points. Planes, pilots, all necessary airport facilities, and plane maintenance are on a fixed-fee plus flying time basis.

The high average of hours flown has made the service feasible and is directly responsible for the cost being competitive with any local charter service.

Four Corners' management likes some other points of its leased service. Planes and pilots are at their disposal at all times. The qualified pilots have been given additional training by the lessor for this particular area and the type of flying required. This is a safety feature not to be overlooked. Also standby planes and pilots are available should the need arise.

Leasing contracts require the same standards of plane operation and maintenance as those of Shell Oil Co., the parent company of Four Corners. Planes, pilots, and records are subject to inspection at any time.

The little two-plane airline has come through its shakedown period in great style. The ships are operating daily schedules from Farmington to landing strips in famous-name oil fields like Aneth, West Aneth, Recapture Creek, White Mesa, and other oil-producing regions of the Four Corners.

The ships flew 180 hours in January, 188 hours in February, 148 hours in March, and 199 hours in April. This period included much of the winter and early spring when weather was figured as a big hazard. Actually, March was the only month when service was affected.

When weather prevents flying, the men stay in the field, taking advantage of crew facilities set up just for such contingencies. They certainly don't mind these few occasions for they know the planes soon will fly again, and that beats the long rough ride on the ground.

Traffic Men Like Proposed Seaway Tolls

THE OIL INDUSTRY this month was given a preview of what it will cost to move crude and products through the St. Lawrence Seaway.

The $471-million project is expected to open full scale next spring.

Traffic experts say the tolls proposed by the St. Lawrence Seaway Development Corp. and the Canadian seaway authority are lower than those charged on the Panama and Suez canals. They are also pleased with a clause permitting the movement of partial cargoes without the payment of tolls on full capacity of a vessel.

The rate for passage through the entire seaway (Montreal to Lake Erie) will be 42 cents per ton for bulk cargo plus 6 cents per gross registered ton of the vessel.

Bulk cargo moving between Montreal and Lake Ontario will be charged 40 cents per ton plus 4 cents per registered vessel ton. And for partial transit between those points, where there are seven locks, the rate will be 15% of the applicable toll for each lock transited.

The schedule provides for tolls on passages through the Welland Canal only. The rate will be 2 cents per ton on bulk cargo plus 2 cents per registered ton of the vessel. A partial transit will be assessed 50% of these charges. At present there are no tolls on the canal.

Seaway officials stressed that this schedule is merely a proposal. Definite figures will be set after hearings by the two authorities in Washington and Ottawa in August.

John Hussey: New Voice on the FPC

• This Louisiana oil lawyer is an outspoken advocate of import controls. He's a friend of the independents, but he's respected by majors, too. Though joining a powerful regulatory body, he's against giving it more authority.

JOHN B. HUSSEY, newest member of the Federal Power Commission, is quite a novelty in Washington. He says what he thinks.

The genial Louisiana lawyer sometimes thinks—and says—enough to wreck the career of a professional politician.

According to the political rule book, President Eisenhower should never have appointed Hussey to any federal job. For in all the oil country there have been few voices stronger than Hussey's in criticizing the President's reluctance to control oil imports.

On at least one occasion during Eisenhower's first term, Hussey pointed out the opposition of the President's cabinet committee and the National Petroleum Council to unrestricted imports.

"Should we have a Cabinet Committee on Energy Supplies and Resources Policy if we are not to follow its recommendations?" Hussey demanded in a prepared statement. "Should we have a National Petroleum Council if we are not to heed its warning? Should we have government restriction of domestic production below efficient producing rates if there is no restriction of imports of foreign crude?"

Hussey repeated similar demands at frequent intervals in public speeches during the next few years. His target was not always the President. Sometimes it was the big importing companies; sometimes it was a little independent pleading for special treatment from the Louisiana Department of Conservation over which Hussey presided.

Obviously, Hussey was in no popularity contest. But his attitude—one of judicial severity seasoned with subtle humor — inevitably brought him the popularity which he openly scorned.

His new job . . . "Judge Hussey," as he's known in Louisiana, began a 5-year term on the Federal Power Commission last week following senate confirmation. He resigned his post as Louisiana commissioner of conservation to accept the presidential appointment.

He was sworn into office in the auditorium of the General Accounting Office building, where the FPC is housed. Associate Justice Tom C. Clark of the Supreme Court administered the oath while 250 FPC staff members looked on.

John B. Hussey
. . . he seeks no popularity.

His record . . . In his new job the 50-year-old Shreveport attorney is a member of one of the federal Government's strongest regulatory bodies. Yet, back in Louisiana, they know he's strongly opposed to the growing concentration of power in the federal Government.

Independent oil and gas producers look on Hussey as a friend. That friendship was strengthened by his frequent blasts at imported oil, which he contended was not bearing its share of taxes.

But the major companies, which did most of the importing, held him in equal esteem. Though they frequently differed with his views they respected his judgment and had confidence in his one-man rule as proration czar in Louisiana.

Hussey was probably as popular a conservation commissioner as Louisiana has ever had, though some would still give the popularity title to Seaborn L. Digby. Hussey succeeded Digby as conservation commissioner of Louisiana back in 1952. Last week he succeeded the same man on the FPC.

During Hussey's reign as conservation commissioner, Louisiana producers have had plenty of complaints. The oil-production allowable was reduced to approximately one-third its former level to make room for production from new wells. While some states were increasing their oil output, the per-well production in Louisiana was lowered so that the life of known reserves was increased from about 10 years to 14 years. This has caused some grumbling.

But Hussey stood firm. Appointed by Gov. Robert F. Kennon, he survived the purge that followed the election of Gov. Earl K. Long, a man whose views of government frequently clash with those of Hussey.

Position on gas . . . Louisiana, the second largest gas-producing state, increased its production from an annual rate of 1.2 trillion cubic feet to 2.1 trillion cubic feet during Hussey's term as commissioner. Meanwhile, the state's gas reserves climbed

PROCESSING

Du Pont Co. and Ethyl Corp. have both increased the prices of TEL antiknock compounds about ½ cent per pound. The increases, effective July 24, follow a series of cuts dating back to April 1957. Based on equivalent TEL content, the new price schedule will be: Motor mix, 59.76 cents per pound; motor mix A, 60.76 cents; and aviation mix, 65.66 cents.

Anchor Gasoline Corp., Tulsa, has started construction of a natural-gasoline plant 8 miles west of Mission, Tex. The plant will have an initial capacity of 35,000,000 cu. ft. daily and can be expanded to 45,000,000 cu. ft. Gas will come from Tabasco field. Pierce Construction Co., Tulsa, is the contractor. The plant is scheduled for completion November 1.

Shell Oil Co. has placed a new 16,000-bbl. Unifining unit and Platformer on stream at its refinery in the Wilmington area of Los Angeles.

from an estimated 31 trillion cubic feet to 51 trillion cubic feet.

Increasing reserves in this country, together with Hussey's past record in opposition to unbridled imports, leads to speculation on his attitude toward gas imports. One of the most controversial cases now before the FPC is one which would involve large-scale imports of gas from Canada.

Personal life . . . Hussey was born in Jefferson, Tex., August 23, 1907, and moved to Shreveport as a teenager. He studied at Georgetown University and received his law degree in 1929. He has practiced law in Shreveport since 1930, specializing in oil and gas law and taxation.

Hussey and his wife, the former Inez Daniels, have five children ranging in age from 15 to 23. His three oldest sons were studying at three separate universities last semester, and all were honor students.

Except to express his opposition to utility-type controls on gas prices, the new Federal Power Commissioner has carefully avoided a statement of policy which might bind him as a member of the FPC.

But natural-gas producers aren't worried about his policies, for they're sure he'll speak his mind when the time comes. They know they have a new friend in Washington, where friends are all too scarce. They know, too, that they can expect no special favors from him.

Oil Prices Cut in Three Areas

PRICE CUTS ranging up to 20 cents a barrel were posted last week by five major crude buyers for certain fields in Texas, the Four Corners area, and the West Coast.

Posting the reductions were Standard Oil Co. of California, Humble Oil & Refining Co., Shell Oil Co., and Sun Oil Co.

Here's the picture:

. . . Socal cut prices up to 20 cents a barrel for low-gravity crudes in California. The new postings for Wilmington and Richfield crudes now range upward from $2.38 (a 20-cent decrease) for 14° gravity, to $3.31 (off 10 cents) for 31° gravity. No reduction was made for light California crude of 40° gravity.

The new prices generally meet reductions posted recently by General Petroleum Corp. and Union Oil Co. of California (OGJ, June 16, p. 66). However, on some grades Socal is still as much as 11 cents above General Petroleum Union.

Socal also posted a 15-cent cut for crude purchased in the Four Corners area, but it still left them 20 cents over Union. Socal was the first to post prices in Four Corners, but Union came in and announced prices 25 cents lower. Union recently cut their prices another 10 cents (OGJ, June 23, p. 76).

. . . Humble posted a 10-cent reduction for certain Upper Gulf Coast mixed sweet crudes in 21 fields. The new price range is from $2.98 to $3.40 a barrel. Humble also announced a reduction of 2 cents a degree of gravity for certain West Texas crudes and condensates from 45° to 55° gravity.

. . . Shell reduced its posted price 10 cents a barrel in five pools in Liberty, Polk, and San Jacinto counties, and 20 cents a barrel in six Dewitt and Lavaca County pools in Texas.

Shell also removed the flat posting of $3.45 per barrel for crude and condensate above 44.9° gravity in Louisiana's Iowa (light) pool. Purchases there now come under the regular price scale for Louisiana Gulf Coast light crude.

. . . Sun cut its posted prices 15 cents a barrel for Sweden crude in 35 pools along the lower Texas coast. The new prices are $3.20 a barrel for 40° and above, with 2-cent differential down to $2.78 for below 20° gravity. The price reduction affects about 18,000 bbl. of daily purchases.

. . . Indiana Oil Purchasing Co. cut prices from 5 to 15 cents in the Texas Gulf Coast area. The new price list showed a 15-cent reduction on prices of crude from six fields, a 13-cent cut in three fields, and 21 other fields were cut 5 cents.

BRIEFS . . .

Interesting features of the new unit include internally insulated catalytic reactors, a modern control room with graphic instrument panel, and separate pneumatic systems which allow operators to shut down by remote control either the desulfurizing or reforming section. The plant was built by Kaiser Engineers, Oakland, Calif.

Shell Oil Co. of Canada, Ltd., will spend more than $2 million for a distillate hydrodesulfurizer at its Shellburn refinery, North Burnaby, B. C. Fluor Corp. of Canada, Ltd., has the construction contract. Construction will start immediately and should be completed by February. The new plant will use a Shell-patented process called trickle-phase hydrodesulfurization to reduce sulfur content of distillate oils.

Skelly Oil Co. is modernizing its El Dorado, Kan., refinery and plans to increase capacity 25 to 35%. Company crews are building an HF alkylation plant to process up to 50,000 bbl. of crude daily. Skelly engineers did the design work. Also under construction is a 12,000-bbl. vacuum unit to produce asphalt and feed stock for the coking unit. Other improvements in various stages of planning or construction include a 500-ton Kellogg delayed coker unit, a UOP platformer, a gas concentration unit, and a cold-lime-soda water treater.

Use of LPG in city buses is growing. A survey by Liquefied Petroleum Gas Association shows that 236 buses will be added this year to the 2,444 already using LPG. The association cited these reasons for the trend: lower maintenance and fuel costs, greater intervals between oil changes, and fume-free exhaust.

D-X Sunray Oil Co. has begun a continuous economic study of its 45,000-bbl. per day Duncan refinery, using an IBM 650 computer. Both technical and marketing variables will be fed into the computer to determine bases for future operations.

Also for Refiners . . .

IN THE NEWS: Canadian refiners increase nominations for Alberta crude (p. 49) . . . High stocks, low demand hurt Penn Grade area (p. 51) . . . OCAW is trying to merge with International Chemical Workers Union (p. 51) . . . Petrochemical production slows down after decade of gain (p. 58) . . . Douglas and San Jacinto splitting profits in deal for Maracaibo crude (p. 62).

PLUS THESE TECHNICAL REPORTS: Gas chromatography is a powerful new tool for chemical analysis (p. 73) . . . Process-stream analyzers minimize loss of valuable material (p. 76) . . . Tidewater refinery cuts maintenance manpower (p. 85) . . . Refinery construction survey (p. 96).

DR. R. H. HUNT describes a distillation project at Shell's refinery research lab. This is one way that . . .

Houston Teachers Learn the Oil Story

THIRTY teachers from the Houston area "graduated" last week from a 3-week petroleum workshop which gives a new dimension to the oil industry's public relations.

It was the first training program of its type ever sponsored by the oil industry.

Some of its unusual features:

. . . **Students received** 3 hours credit toward advanced degrees in education from the University of Houston.

. . . **Thirty companies** in oil and allied industries underwrote the program by providing tuition-free fellowships to the 30 students.

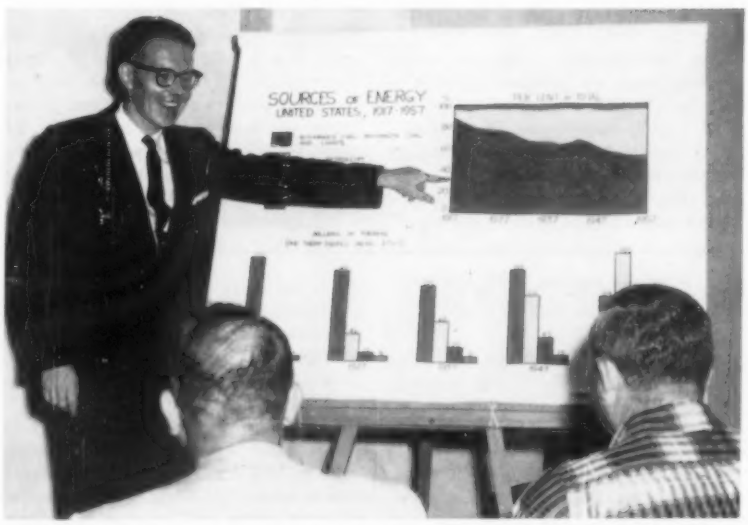
. . . **The industry** furnished most of the faculty, including more than 30 guest lecturers, each an expert in his own field.

. . . **In addition** to classroom work at the university, the course included three field trips to oil installations.

R. E. DOBYNS

The experimental project was planned by a joint committee from the oil industry, public schools, and the University of Houston. Teachers, representing some 27 elementary and high schools in Harris County, were nominated by their school administrators to attend the workshop.

The project was organized by R. E. Dobyns, Shell Oil Co., who is chairman of the Oil Information Committee for South Central Texas.



CONOCO'S Henry Corey explains oil's importance to U. S. economy.

"We've always felt that people who know us like us," he says.

Cost of the course was estimated at about $1,700, paid by the local API committee through contributions from participating companies.

The committee felt that its work would be more effective in the long run by educating teachers rather than by taking its story directly to elementary and high-school students. Each teacher has the opportunity to influence the thinking of children for years to come, it was pointed out.

False ideas . . . There already have been some dividends to the oil industry. One teacher, for instance, held the opinion that proration of oil production would reduce the ultimate output of a well and therefore is not truly a conservation measure. The teacher was convinced otherwise by William J. Murray, Jr., member of the Texas Railroad Commission, who was one of the guest lecturers.

Another teacher wanted to know if a cat cracker refines crude oil from a wildcat. A logical question, the instructor agreed. It was indicative, though, of the lack of understanding of the oil business.

FPC Asks Cooperation

. . . from states as a means of cutting down on conflicts over jurisdiction arising from natural-gas regulation.

NEED OF CLOSER cooperation between the Interstate Oil Compact Commission and Federal Power Commission on conservation matters was cited at the midyear meeting of the compact in Salt Lake City.

Wyoming Gov. Milward L. Simpson, compact chairman, proposed creation of a new committee of the IOCC to work with the FPC as a means of reducing conflicts of jurisdiction.

Such a committee was virtually invited by members of the FPC who took part in a panel discussion of gas conservation at the compact meeting.

Panelists were Commissioners Arthur Kline and William R. Connole; Carl T. Kallina, chief of the bureau of rates and gas certificates; and W. Russell Gorman, assistant general counsel of FPC.

All of them declared that FPC is faced with serious legal problems in regulating field prices of gas where conservation is a factor in production. They pointed out that both the natural gas act and several court decisions specifically reserve conservation matters to the states. They disclaimed any intention of encroaching on state powers and asked for two-way cooperation with state regulatory bodies on mutual problems.

FPC members idea . . . The suggestion for a compact commission committee came from Connole.

Connole offered three areas for state-FPC cooperation:

. . . **A broader approach** to and concept of conservation than that in the compact.

. . . **Development of a** national fuels and energy policy which would establish oil and gas conservation goals and guide the work of both FPC and the state bodies.

. . . **Removal of unfounded** suspicion that either state or federal Government is trying to usurp the powers of the other, and permit both to work with instead of against each other.

Kline confined his discussion entirely to the problems raised by the Supreme Court invalidation of Kansas and Oklahoma minimum price laws. He said that perhaps FPC should consider conservation as an element of price and set prices so as to prevent waste, but at the moment FPC is concerned with what to do about the contracts affected by invalidated laws.

Legal conflicts . . . Gorman discussed the apparent conflicts in the law as to the jurisdiction of FPC and the states in gas production.

He suggested that, if the courts approve, a parallel might come from tax law and that it may be held that production ends and transportation begins when gas is reduced to possession at the surface.

Kallina discussed the statutory provisions for abandonment of service. He declared that FPC has no intention of considering it abandonment or attempting to interfere in a case where gas is withdrawn from pipeline sale in accordance with a state order for recycling or other conservation purpose.

He asked help from state bodies in FPC studies of reserves, the effect of proration systems on deliverability, and in making studies of the joint cost of producing oil and gas. He said FPC is not receiving information from the states that it needs, and he suggested that the state commissions may obtain valuable information from FPC files.

Rule Change Urged

to aid strat-trap search. IOCC will seek revisions.

REGULATIONS COVERING stratigraphic drilling must be liberalized to encourage exploration for hard-to-find strat traps. The Interstate Oil Compact Commission's research committee was told by D. E. Smith, Salt Lake City district geophysicist for Pan American Petroleum Corp.

Smith's paper was part of a study the committee has under way and the committee expects this fall to complete a detailed report on stratigraphic drilling and make recommendations for changes in state regulations.

Smith said the Rocky Mountain states have no satisfactory regulations on drilling wells for geological information.

He recommended that exploration be encouraged by treating strat tests as geological work but that abuses be prevented by rules which classify a strat test as an oil well as soon as there is evidence of a discovery.

His recommendations would:

. . . **Set up clear** definitions for strat tests.

. . . **Permit the operator** to drill whatever size wells and on any spacing pattern called for by the geological conditions rather than in conformity with arbitrary rules.

. . . **Permit the operator** to keep reports and well logs confidential for 1 year.

. . . **Reclassify a strat** test and place it under oil well regulations as soon as the operator sets casing to a prospective producing horizon.

Stripper Yardstick

proposed to settle issue over proration of floods.

A NEW SYSTEM of classifying and reporting on stripper fields and marginal water-flood fields was recommended last week by E. Morris Seydell, of Seydell Engineering Co., Wichita Falls, Tex.

His suggestion was given the Compact Commission as a means of narrowing the controversy over proration of water floods. It would classify certain fields as marginal and exempt them from proration.

In general, a lease or unit project would be classified as marginal if producing no more than 10 bbl. per day per well or if more than 80% of primary reserves is already produced.

Each such field would file a special monthly production report which would:

. . . **Give** current figures on stripper water-flood production.

. . . **Show** such production above the prorated level for comparable primary production.

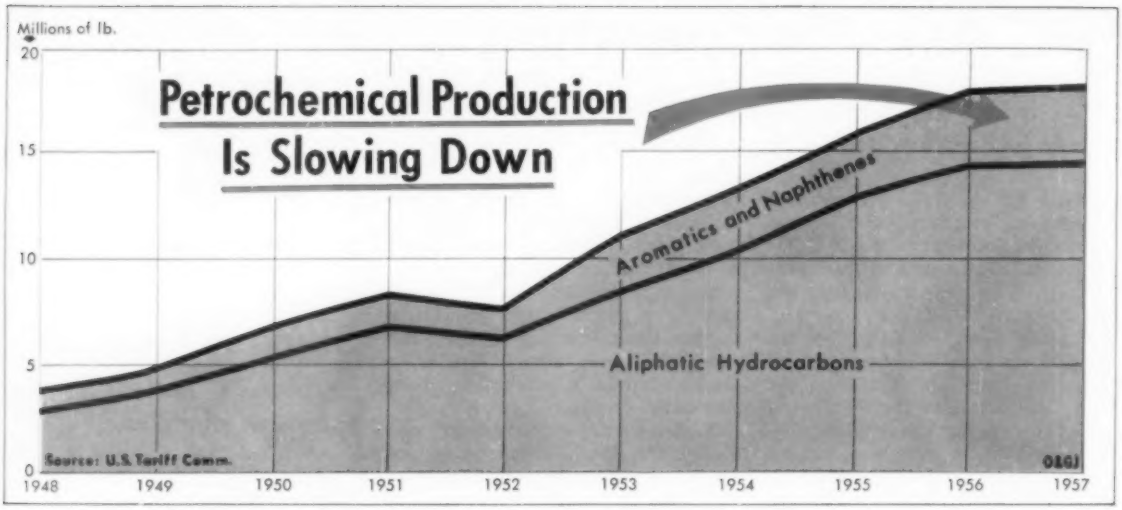
. . . **Provide** basis for forecasting future water-flood production.

More Gas Going to Chicago

NATURAL GAS PIPELINE CO. of America will be able to increase deliveries to the Chicago area by at least 100,000 M.c.f. daily this winter in spite of earlier troubles which stymied badly needed expansion.

Clearing the way for the construction program was Federal Power Commission approval of a rate settlement worked out with Natural customers. It calls for a refund of $10,137,854 plus 6% interest to wholesale customers in Kansas, Illinois, Indiana, Iowa, and Wisconsin.

The FPC also gave temporary approval for Natural to build 490 miles of 36-in. and 21 miles of 26-in. loop between Fritch, Tex., and Joliet, Ill. Construction will cost an estimated $81,840,000.



A Decade of Gain—and Now a Decline

THE PETROCHEMICAL business has slipped into a decline in recession-ridden 1958. When the year is out, the production figures are expected to fall below those of 1957.

While there have been some publicized price cuts, there is also considerable cut-rate dealing under the table because of the big oversupply.

First quarter earnings were well below those of 1957's first quarter, and the second quarter appears to have been no better.

Two related factors have contributed to the industry's plight: The recession and overcapacity. Many companies, looing ahead to big demands of the early 1960's, have completed their new plant construction already. And this has come at the very moment of a business decline.

Within the industry price cutting through private deals and special discounts has been reported.

Price cuts made in the open have affected such petroleum-based products as polyethylene, tetratethyl lead, methanol, and synthetic ammonia.

Product by Product—Some Up, Some Down

(Thousands of pounds)

	1957	1956	1955
Aromatics and naphthenes			
Distillates and solvents	671,196	725,496	642,649
Benzene	851,628	818,123	722,650
Cresylic acid	35,191	29,772	24,470
Naphthenic acid	16,774	22,937	16,687
Toluene	1,121,585	946,789	1,038,290
Xylenes	829,843	894,580	699,455
All others	38,780	21,478	30,404
Totals	3,564,997	3,459,175	3,174,605
Aliphatic hydrocarbons			
C_2 hydrocarbons	4,586,161	4,164,511	3,493,439
C_3 hydrocarbons	4,249,571	3,823,861	3,338,615
C_4 hydrocarbons	4,573,550	5,039,028	4,569,184
C_5 hydrocarbons	141,518	310,709	250,752
All others	973,598	1,100,746	1,352,367
Totals	14,524,398	14,438,855	13,004,357
GRAND TOTALS	**18,089,395**	**17,898,030**	**16,178,962**

No surprise . . . While the market for petrochemicals is soft today, the development could hardly have caught the industry by surprise.

Despite the increase in capacity, production gains have been slowing down for some time. The slide in production began in 1957.

The burgeoning industry, for the second time in a decade tapered off last year to catch its breath. Production of basic organic chemicals for further conversion rose just a shade more than 1% in 1957 over 1956.

Except for a 10% drop in 1952, gains of 10 to 50% have been scored in each of the past 10 years.

The U. S. Tariff Commission has issued a preliminary report which shows the slowdown in petrochemical gains last year. The report says production of synthetic organic chemicals from petroleum and natural gas totaled 18,089,395,000 lb. against 17,898,030,000 lb. in 1956.

Aromatics and naphthenes represented 3,564,997,000 lb., up 105,822,000 lb., while aliphatic hydrocarbons represented 14,524,398,000 lb., up 85,543,000 lb.

Biggest contributor to the gain in the field of aromatics and naphthenes was toluene. It was up 174,796,000 lb., an increase of better than 18%. This was due primarily to a marked gain for nitration grade toluene.

The aliphatics . . . Ethylene, propane, 1,3-butadiene, and propylene, in that order, lead the list of aliphatics on a volume basis. All four showed increases in 1957—ethylene about 7.5%, propane about 13%, 1,3-butadiene about 2.5%, and propylene about 7%.

Among the aliphatics, the C_2 and

C_3 hydrocarbon groups showed good gains over the previous year but barely sufficient to offset sharp declines in the C_4 and C_5 groups. Only 1,3-butadiene, among the latter, was up.

Two new categories were identified in the aliphatics group in 1957. These were methane, with reported sales of 39,662,000 lb., and di-isobutylene, with production of 110,479,000 lb.

Possibly the most significant change in other aliphatics was the drop in 1-dodecene (tetrapropylene). Production fell about 13%, attributable to a switch by detergent manufacturers from solids to liquids.

Production figures count . . . Since some basic petrochemicals are produced by companies for their own use, the Tariff Commission's production figures, rather than sales, are an indication of the relative level of the business.

While production was slightly higher last year than the year before, sales were down a trifle more than 6%. Sales amounted to 10,329,858,000 lb. in 1957 against 11,031,740,000 lb. in 1956.

Propane is far away the most heavily trafficked of all the chemicals involved. Sales of propane totaled 2,435,333,000 lb. and represented 99% of the production reported. By comparison, ethylene, one of the most popular "building blocks," sold only 619,255,000 lb. out of a production of 3,946,602,000 lb., or roughtly 15%.

Sales of 1,3-butadiene represented about 60% of production. While production was up from the year before, sales were down. The latter dropped from 952,123,000 lb. to 934,462,000 lb. in 1957. Thus, despite the increase in the proportion of synthetic to natural rubber, sales are down because of the drop in rubber demand.

Price increases . . . The unit value of these chemicals was up last year.

The Tariff Commission shows the average 1957 value of the chemicals as 3.6 cents per pound against 3.0 cents in 1956.

Among the more substantial increases were those in 1,3-butadiene, 0.9 cent per pound; isobutylene, 0.7 cent; and benzene, 0.9 cent.

Biggest jump, however, was for a comparatively small item, aliphatic hydrocarbon derivatives, which include di-tert-butyldisulfide, miscellaneous mercaptans, and aliphatic acids. They rose from 12 cents to 23 cents per pound.

Applying the unit sales value to all 1957 production gives it a gross value of $650,000,000. This definitely puts it into the category of big business.

PIPELINE BRIEFS . . .

Coastal Transmission Corp. has awarded contracts to construct its four compressor stations to Gasoline Plant Construction Corp., Houston. Coastal will build stations at Robstown, Tex., 2,000 hp.; Bay City, Tex., 4,000 hp.; Beaumont, 6,000 hp.; and Baton Rouge, La., 8,000 hp. The stations are to be completed by March 30, 1959. Coastal will build a line from McAllen, Tex., to Baton Rouge to deliver gas to Houston Texas Gas & Oil Corp., which will build a line from there to Miami, Fla.

The new pipeline across New Mexico from the Four Corners area is expected to be in normal operation this week. Built by Texas-New Mexico Pipe Line Co., the 512-mile, 16-in. crude-oil system has been undergoing tests for several weeks (OGJ, May 12, p. 81).

The line has a rated capacity of 50,000 bbl. per day, but operators have not disclosed how much crude actually will move through it during the early stages. Part of the crude is expected to go to Gulf Coast refineries and part to the Mid-Continent.

Southern Counties Gas Co. of California has awarded a contract to Engineers Limited Pipeline Co. for 19 miles of 30-in. line from Newhall to Burbank. The project is under way and will be completed by November 1. The line is jointly owned with Southern California Gas Co. Southern Counties plans to lay a 20-mile, 24-in. line from Temecula northward, also to be completed by November 1.

Texas Gas Transmission Co. plans to spend $20 million to build 126 miles of pipeline and 9,040 compressor hp. on its system from Louisiana and Texas to Ohio. The expansion will raise delivery capacity by 113,000 M.c.f. to 1,500,000 M.c.f. daily.

Texas Gas' application with the FPC seeks approval for 92 miles of 30-in. in Louisiana and Mississippi, 19 miles of 26-in. between Hardinsburg and West Point, Ky., 12½ miles of 16-in. in Jefferson Davis and Acadia parishes, Louisiana, and 15 miles of 16-in. in Kentucky, Indiana, and Illinois. Horsepower will be added at Pineville, La.; Kenton, Tenn.; Calvert City and Slaughters, Ky.; Dillsboro and Petersburg, Ind., stations. The construction is to be completed for the 1959-60 heating season.

Continental Pipe Line Co. is expanding three stations on its Wyoming crude system. Oil Capital Construction Co. is installing 300 hp. at Cheyenne, 600 hp. at Little Bear, and 600 hp. at Goshen. Completion is scheduled by July 15.

Service Pipe Line Co. has awarded a contract to O. R. Burden Construction Corp., Tulsa, to take up, recondition, and relay 29½ miles of 8-in. crude line between Post and Cogdell stations in Garza and Kent counties, Texas. Paul Thibodeaux will be superintendent for the project, headquartered at Post.

Michigan Wisconsin Pipe Line Co. has received full FPC approval of its $19,453,000 expansion program approved earlier by an examiner. The company will lay 56 miles of 20-in. lateral from its main line to connect Laverne field, Harper County, Oklahoma; gathering lines in Laverne; 20.5-mile loop of its 22-in. Austin storage line in Michigan; and 31,500 hp. in nine new main-line compressor stations. Capacity will be increased 40,000 M.c.f. daily.

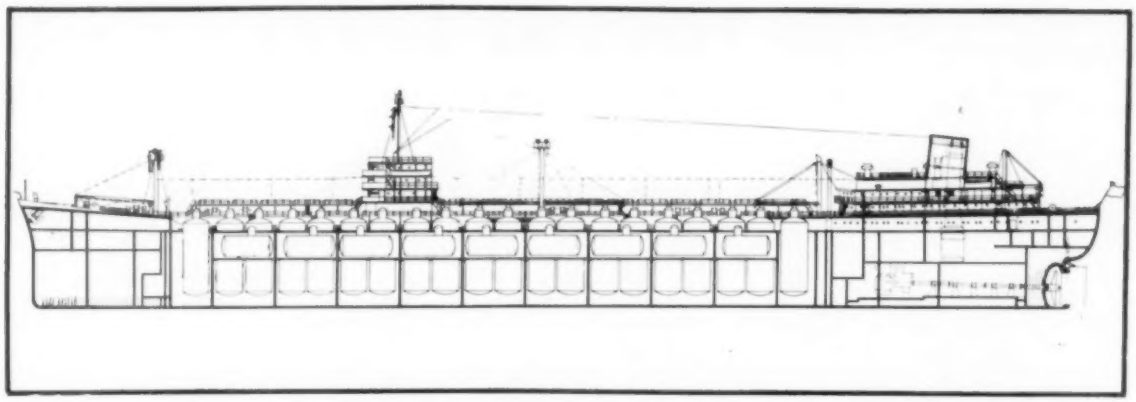
Consolidated Gas Utilities Corp. plans to build 43 miles of pipeline this summer. The company has just completed a 13-mile, 16-in. line to replace a 14-in. line which had to be relocated because of construction of Foss Reservoir in Custer County, Oklahoma. A 20-mile, 12-in. line and 10 miles of 8-in. will be laid between Sayre and Altus. These projects are to be completed by September 15.

Shell Pipeline Corp. will use an RCA microwave communications system to link its Norco, La., headquarters with two drilling areas in the Gulf of Mexico.

Also for Pipeliners . . .

IN THE NEWS: Pipeline company uses planes to solve transportation problem at Aneth (p. 52) . . . Outspoken John Hussey is sworn in as FPC member (p. 54) . . . FPC reopens Colorado Interstate Gas Co. rate cases (p. 60) . . . Pipeline construction is included in Aramco's 1958 expansion plans (p. 63).

PLUS THESE TECHNICAL REPORTS: IBM computer determines unsteady-state flow of natural gas (p. 86) . . . Meter calibration procedures (p. 107).



CYLINDRICAL TANKS of new "Esso Puerto Rico" will hold 89,000 bbl. of LPG as . . .

Biggest Crude-LPG Tanker Nears Completion

THE WORLD'S largest combination crude and LPG tanker, the 32,817-dw. ton Esso Puerto Rico, will be launched next month in Italy.

The new vessel isn't the first ship to carry both crude and LPG, but it is by far the largest ever built for such use and the first designed specifically for that purpose. The 690-ft.-long ship will carry 210,000 bbl. of crude and 89,000 bbl. of LPG fully loaded. It is powered by a 16,200-hp. turbine and will be able to make 17 knots.

The LPG will be carried in 58 cylindrical tanks, 40 of them set vertically in the crude compartments and 18 horizontally over the lateral cargo tanks. The LPG cylinders were manufactured in the United States and shipped to Italy for installation.

The vertical LPG tanks are 50 ft. tall and 16 ft. in diameter. All the tanks and LPG handling equipment are designed for 150 psi. pressures. LPG handling equipment consists of three steam turbine-driven centrifugal pumps, a turbine-driven centrifugal compressor, a condenser, and a humidity separator.

LPG is unloaded from the tanks by increasing pressure and forcing the liquefied gas through discharge lines. Vapors remaining in the tanks are passed through separators to extract any moisture impurities before they pass through a compressor and condenser.

The tanker is being built at Cantiere Navale di Monfalcone of the Cantieri Riuniti dell'Adriatico for Panama Transport Co. It will be used in Western Hemisphere trade. There are several small vessels in service which carry both oil and LPG, and several times in the past Esso has fitted T-2 tankers with LPG tanks for temporary use. The Natalie Warren, a cargo vessel converted to an LPG carrier by Warren Petroleum Corp., is the only ship of any size devoted to this service. It has a capacity of 40,000 bbl., less than half the LPG capacity of the Esso Puerto Rico.

FPC Gives New Hope to Rate-Bound Gas Firm

SOME rate relief may be forthcoming for hard-pressed Colorado Interstate Gas Co. But the company has lost some of the points it was trying to make in its 4-year-old argument with the Federal Power Commission.

The FPC has reopened CIG natural-gas rate cases which have been in dispute 4½ years. The firm has collected $83 million in protested rates, subject to refund, since January 1, 1954. The total is increasing about $2 million a month.

The higher rates were put into effect January 1, 1954; February 1, 1955; July 1, 1957; and February 5, 1958.

Reopening of the cases was requested by CIG on grounds the FPC record should include cost data up to 1956. Such data, including cost of purchased gas and other operating expenses, is used in determining justification of proposed rate increases.

In its new opinion, the commission:

. . . **Ruled the evidence** is insufficient to show that CIG should be allowed more than the cost for production of its own gas computed under the traditional rate-base method.

. . . **Denied CIG's motion** for a broader reopening of the record to receive additional evidence on field prices and of cost of service for the period the higher rates were in effect subject to refund.

. . . **Denied request by city** and county of Denver to reject the rate filings on the basis of the Mobile and Memphis cases. The motion contended that since there was no consent to the increases, the proceedings must be dismissed.

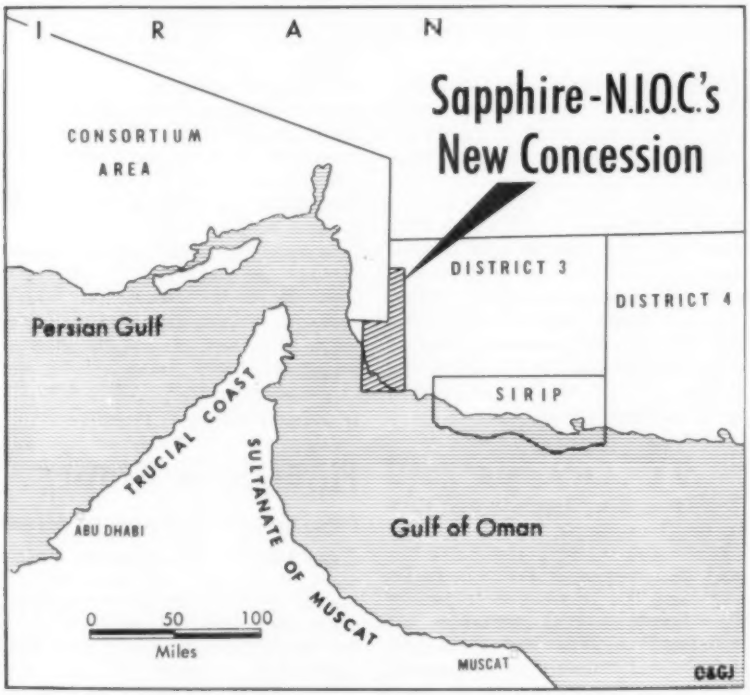
. . . **Disallowed CIG's claim** that it was entitled to include in its cost of service certain federal and state income-tax advantages which became available because of the 1952 merger with Canadian River Gas Co.

. . . **Allowed a 6% over-all rate** in computing the company's cost of service for the period January 1, 1954, through June 30, 1957. CIG had sought a 6½% rate of return.

In ordering the cases reconsidered the FPC took no cognizance of findings by one of its examiners, Samuel Binder, who recommended refunds amounting to $37,300,000. This figure later was increased to $41 million after the FPC added 6% interest to the $37,300,000.

Binder singled out 1954 as the test year in figuring cost data for 1954 and 1955.

The commission, however held 1954 was an inappropriate test year for determining the cases. The FPC ruled that 1954 could be used as the test year in determining costs for 1954 and 1955. But the commission said the year ended September 30, 1956, should be used in arriving at company costs for 1956 and 1957.



Canadians Win Acreage

. . . in partnership deal with Iran. Terms are similar to Pan Am, Italian agreements. No cash bonus is involved. Sapphire will spend $18 million for exploration.

WHILE the world's big oil companies scrambled and dickered for big plots of new exploration acreage in Iran, a little Canadian independent quietly signed up a small concession deal in the Middle East.

Sapphire Petroleums, Ltd., Toronto, has made a deal to take on National Iranian Oil Co. as a partner in an operation which covers 1,000 sq. km. (about 386 sq. miles) just north of the Gulf of Oman.

The agreement signed with NIOC was described last week in Toronto as "similar to the Pan American deal, but with no cash bonus." It was presented to the Iranian Majlis last week for approval.

The deal calls for Sapphire to form a new company, Iran Canadian Oil Co., with the government oil company as an equal partner. This is similar to agreements signed with NIOC by both the Italians and Pan American, an affiliate of Standard Oil Co. (Ind.).

The acreage which the Canadian firm will operate is in the new petroleum District 3 created by Iran last December (OGJ, Dec. 9, 1957, p. 86). It adjoins the southern tip of the international consortium's acreage and extends to the south and along the east edge of the consortium "finger" which loops around the Strait of Hormuz. The narrow neck of water separates Iran from the Trucial Coast and joins the Perisan Gulf with the Gulf of Oman.

Near Italian block . . . The Sapphire-NIOC acreage lies just to the west of one block which ENI, the Italian government company, has with NIOC under the name SIRIP. Only about 10% of the Sapphire block extends into the Gulf of Oman.

The new agreement has been under negotiation for months. It was signed a couple of weeks ago by Abdollah Entezam, chairman of NIOC, and Victor Spiegelmann, Sapphire vice president of production. It was not revealed until presented to the Iranian parliament.

Under the agreement Sapphire has agreed to spend $18 million on exploration. The details of the agreement were not released and Spiegelmann was en route from Tehran to Toronto last week. Sapphire officials said the company has done no geological or geophysical work in the area covered by the agreement, but has "studied what is available." A number of oil seeps have been reported on the concession block.

Sapphire's holdings . . . A young Canadian company, Sapphire has varying oil royalty interests in Alberta, British Columbia, and slightly less than 7% working interest in 22,957 acres of leases covering Athabasca tar sands in the Edmundson Creek area of Alberta.

The company has a U. S. subsidiary, Sapphire American Petroleums, Inc., incorporated in Kansas, which handles its oil interests in Wyoming, Texas, Illinois, and Nebraska.

Three years ago this company bought a number of producing properties on the Clareton trend of the Powder River basin, Weston County, Wyoming, from Garnak Drilling Co., Denver. In September 1957, the company started a water-flooding operation in the area to try and counter rapidly dropping reservoir pressures and production.

Sapphire's annual crude production is on the decline after reaching a peak of 978 bbl. daily in 1955. Last available figures for production for the year ending May 31, 1957, show a total output of about 500 bbl. daily from all its properties.

Deep Dominican Test Is Dry

THE FIRST deep test ever drilled in the Dominican Republic has been abandoned as a dry hole.

But the operators, H. S. Cole, Jr., & Son, Houston, plan to spud a second well within a few weeks on the 2,100,000-acre concession. Location of the second wildcat has not been announced yet.

Drilled to 10,800 ft., the first Cole well hit no commercial shows, a spokesman announced. The first was near Villa Isabel, in the Cibao Valley (OGJ, Nov. 11, 1957, p. 131).

Cole & Son is exploring the large concession, located in the northern part of the republic, under an agreement with Petrolera Dominicana, C. A., concessionaire of the Dominican Government.

Paris Discovery Is Confirmed

. . . by Petrorep. Second well flows 200 bbl. daily, and third stepout has good shows. More drilling scheduled.

FRENCH hopes for more oil reserves at home climbed another notch when production was confirmed at a new discovery 27 miles east of Paris.

The Coulommes 2, a mile west of the Paris basin's first discovery well, was completed for 200 bbl. daily through ⅛-in. choke from the Dogger section of the Middle Jurassic lime at 6,170 ft.

This confirms the good strike made by Ste. de Recherches Petrolieres dans la Region Parisienne (Petrorep) last February at the Coulommes 1, 5 miles southwest of Meaux (OGJ, Mar. 3, p. 85).

The discovery well, the most important French oil find since Parentis 4 years ago, recovered 50 bbl. of 33.5°-gravity crude on a 75-minute drill-stem test of a 66-ft. pay section at 6,060-6,126 ft.

Other rigs busy . . . Good cores were taken at still another stepout.

The Coulommes 3, a half mile south of the No. 2, had several oil-impregnated cores, and a Petrorep official said this well "looks as good as the other two."

The wells are on an anomaly found by a seismic survey and confirmed by core holes. The structure is about 12 miles long and 6 miles wide. Porosity in the discovery was 15%, and permeability was described as good.

A fourth well is under way, and tentative location has been staked for the fifth. Coulommes 4, just east of the discovery, was drilling below 4,000 ft. last week.

Petrorep is not confining its drilling activity to this structure. Plans also call for a 6,000-ft. Dogger test 16 miles northeast of the discovery this summer. Called the CR 1, the test is just 5 miles from a Mobil Repga concession.

About 60 miles south of the Coulommes wells and slightly to the east, Fropex is testing a show found at 6,700 ft. in a well at Chateaurenard. Fropex is a joint French-American operation in which American Overseas Oil Co., France, S.A.F., (Caltex) has a 45% interest.

Most of the big Paris basin, which covers much of north-central France, is under license or applications are pending. The Petrorep license takes in 1,588 sq. miles surrounding Paris, but mostly northeast of the capital.

Shows have been found elsewhere in the basin, but none were commercial. However, in West Germany, the Dogger is a good producing formation.

Crude to LeHavre . . . The discovery was scheduled for completion last week.

The Coulommes 1, drilled to 8,000 ft., was plugged back to original pay zone for completion attempt. Apparently, the pay was mudded off during drilling. A U. S. engineer is assisting in completion efforts.

About 700 bbl. of 34°-gravity crude from the No. 2 well has already been shipped by truck to a bulk terminal at Villeneuve sur Garenne near Paris on the Seine River.

Plans call for collecting 5,000 bbl. and then barging it to LeHavre for refining. The terminal is owned by Petrofrance, a local marketing and shipping firm. Petrofrance owns 51% interest in Petrorep. The Rothschilds and other French investment trusts own the remaining 49%.

The Paris discovery was Petrorep's first wildcat.

Wild Well Capped

in Iran. Kinley ends ticklish assignment after long battle.

IRAN'S wild Ahwaz well was finally tamed last week, more than 2 months after it blew out and caught fire.

Myron Kinley, the Houston fire fighter who put out the stubborn fire early this month, capped the well and got it under control early in the morning June 22.

Wellhead pressure registered 3,100 psi. once the final valve was closed after new fittings had been gingerly attached at the surface. Engineers started pumping water into the well immediately to kill it. This will be followed by mud.

The troublesome well easily set a new blowout record for the Middle East. It burned for 44 days before Kinley's fifth effort to snuff out the fire with explosives was successful (OGJ, June 9, p. 82). It took another 3 weeks' work to cap the well.

It was not known last week if Iranian Oil Exploration & Producing Co., operating company for the international consortium, will attempt to deepen the hole now that the well is under control. The well blew out April 19 during a coring operation at 8,093 ft. It had apparently just topped Iran's Asmari limestone zone.

Low shut-in pressure . . . The 3,100-psi. shut-in. pressure was surprisingly low after all the trouble the well caused. It blew an estimated 100,000,000 cu. ft. of gas daily with a quantity of condensate and crude burning with a 250-ft. plume.

It was the sixth well drilled in the last 30 years in an effort to make the Qarait structure at Ahwaz yield production. None of the previous five holes reached the Asmari before they were abandoned because of mechanical trouble (OGJ, Apr. 28, p. 115, and May 26, p. 72).

Firms Split Profit

from crude shipped to West Coast from Maracaibo field.

THE LONG-TERM contract under which new Lake Maracaibo crude is moving into U. S. West Coast markets is a profit-split deal.

The supply contract was first revealed 3 months ago in a joint announcement by Douglas Oil Co. and San Jacinto Petroleum Corp., but few details were spelled out (OGJ, Mar. 24, p. 105).

Last week, W. G. Krieger, Douglas president, gave his stockholders the details of the San Jacinto agreement. It calls for San Jacinto to be paid for production costs of the crude, Douglas to deduct the transportation and refining costs, and what's left is split down the middle.

Douglas took the first shipment of crude last month and has scheduled regular shipments in line with its import quota of 4,700 bbl. daily for the first half of this year. The company hopes to boost this "substantially" after the first of next year.

As part of the deal, San Jacinto advanced Douglas $1,250,000 at 4½% to acquire additional storage and pipeline facilities to handle the crude. Douglas has bought a 120,000-bbl. tank farm near its 7,000-bbl. daily Paramount refinery and linked it to the plant with a 12-in. pipeline. Another 190,000 bbl. of new storage is being built at the refinery.

Prolific field . . . San Jacinto owns 30% of a 2,000-acre National Reserve block on the east edge of Lake Maracaibo where a prolific Miocene field has already been established.

San Jacinto calls its new field Mar-

lago and has just completed its fifth producer (OGJ, June 23, p. 88). Early this month the company and its partners produced 8,800 bbl. daily from the field.

San Jacinto is strictly an oil producer. It has no refining or marketing facilities. Douglas Oil is an integrated West Coast company with three refineries in California.

Suez Work to Start

soon. Deepening project will allow large tankers to pass.

THE FIRST STAGE of a mammoth program to deepen and widen the Suez Canal is about to get under way.

Three dredging firms, two from U. S. and one Hawaiian, will deepen the canal from 34 to 37 ft. in the $18-million first step of a three-stage program.

Leland E. Yeager, president of Standard Dredging Co., New York, said last week his firm has a letter of intent from Pres. Gamal Abdel Nasser's government. The formal contract is expected to be signed in the near future, Yeager said. The Egyptian Government expects to pay for most of the initial work out of canal tolls.

The other two firms involved in the contract are Atlantic Gulf & Pacific Co. and Hawaiian Dredging Co., Ltd.

The second stage will be deepening the canal to 40 ft. Then in another 5 years, Egypt wants to do a $200-million over-all widening and improvement job on the canal.

The 37-ft. depth will allow tankers up to 29,000 tons to use the canal. At present maximum draft for tankers is only a little more than 34 ft. which prevents today's large tankers from using the canal fully loaded.

Chaco Starts Bolivia Wildcat

A SUBSIDIARY of Tennessee Gas Transmission Co. has spudded its first wildcat on the 900,000-acre Bolivian concession formerly held by Glenn McCarthy, Inc.

The wildcat, 1 Agua Salada, is projected to 12,000 ft. to test the Tupambi sand of Permian age. Location is in the southwest portion of the lease in southern Bolivia, and only a few miles north of Argentina's two major oil fields, Madrejones and Campo Duran.

Chaco Petroleum, S. A., a Tennessee Gas subsidiary, is operator for the four-company combine which took over the concession in 1957.

Aramco Plans Big Expansion

ARABIAN American Oil Co. will spend $63 million this year expanding its Saudi Arabian operations in spite of a depressed world market for its oil.

The capital expenditure figure, revealed by Aramco last week in its annual report to King Saud ibn Abd al-Aziz Al Faisal Al Saud, is $2 million under the figure budgeted for 1957 by Aramco.

In the annual report, a flossy four-color printing job with charts, graphs, photographs, and maps printed in both Arabic and English, the company outlines its accomplishments of the last year and plans for the next. Here are some of the highlights of 1957.

... **Average daily production** of 992,114 bbl. This is a record, but only a slight increase over the 986,129 bbl. daily produced in 1956.

... **Refinery runs** at Ras Tanura averaged 192,623 bbl. daily.

... **The first offshore field** in the Persian Gulf, Safaniya, went on production.

... **New discoveries** were made at Manifa, also an offshore field, and Khurais, 75 miles to the west of Aramco's existing fields. A 12-mile stepout extended the mammoth 140-mile Ghawar trend another dozen miles to the north.

... **Eleven oil wells** and one gasser were completed by Aramco giving the country a total of 189 producing wells.

For 1958 Aramco has the following plans:

... **A $29 million gas-injection** system for Ain Dar area of Ghawar field. This is the largest single item in the capital expenditure budget. The project will inject 200,000 M.c.f. of gas daily into the producing reservoir.

... **Expansion of the Abqaiq** injection program to a rate of 210,000 M.c.f. daily.

... **Boosting production of Safaniya** field to 175,000 bbl. daily by looping and adding pumping facilities on the Safaniya-Ras Tanura pipeline.

... **A new 2,000-bbl. alkylation plant** for the Ras Tanura refinery for the production of aviation gasoline. LPG facilities will be expanded to produce 1,500 bbl. daily.

... **Extension of Ras Tanura's north pier** by another 800 ft. to increase the tanker berths from 8 to 10.

... **Another pumping unit** at Nariyah to raise the capacity of the trans-Arabian pipeline system moving crude to the Eastern Mediterranean to 460,000 bbl. daily.

... **Extension of the water-injection** system at Abqaiq, in the northern perimeter of the field.

Indonesian Acreage Sought

A CANADIAN company backed by U. S. money has offered Indonesia a full partnership in a Sumatran oil operation in return for concessions.

Reports from Djakarta last week indicated Asamera Oil Co., Calgary, (successor to New British Dominion Oil Co.) has made the formal proposal. Government officials were silent on the offer.

Gen. Thomas B. Wilson, Asamera chairman and former president of Trans World Airlines, has been talking with government officials about the deal since early this year. Last week, General Wilson and Anthony Diamantidi, a director of the company, were en route to the United States.

The pair offered to form a joint company with the government to be called Asamera Oil (Indonesia), Ltd. In return Asamera wants exploitation concessions covering 2,250,000 acres in Sumatra, Borneo, and Java for which it has already acquired exploration licenses. Of prime interest is one 720,000-acre Sumatra block in the Palembang region.

The Djakarta reports last week said Asamera proposes investing $200 million in the venture and agrees to sell its share of the operation to Indonesia at the end of 30 years.

The background . . . The newest effort to induce Indonesia to grant new concessions was actually born nearly a year ago.

At that time New British Dominion Oil changed its name to Asamera and acquired a half interest in Nusantara Mining Corp., from Baud Corp., of The Hague and Djakarta. Nusantara held the exploration licenses involved in the deal.

Baud Corp. is a wholly owned subsidiary of Sea Oil & General Corp., New York, which is headed by Diamantidi.

In return for the half interest in Nusantara, the newly named Asamera turned over 4 million shares, 50%, of its stock to Baud and Sea Oil.

If Asamera succeeds, it will be the first company to acquire new concessions in Indonesia since before World War II.

The Spraberry can be flooded

"Give us unitization, so that we can get the job done"

BY L. F. ELKINS

REMEMBER the Spraberry boom of 7 years ago? Hotel rooms in Midland, drilling rigs in West Texas, and casing were almost impossible to obtain. There were visions of thousands of wells required to drill the many productive acres indicated by intergrowth of the Spraberry fields—Tex Harvey, Germania, Midkiff, Driver, Pembrook, Aldwell, Weddell, and Benedum. Operators and promoters talked of recoveries up to 10,000 bbl. per acre. During 1951, drilling activity increased from only a few wells to 235 active rotary rigs. Nearly 200 wells were completed during December 1951.

Optimism vanishes . . . This optimism soon waned to abject pessimism. Production in the developed areas began to decline and gas-oil ratios skyrocketed. Drilling declined in the last half of 1952 and reached a low of 10 wells completed during November.

Background information . . . The Spraberry is a thousand-foot section of sands and shales of lower Permian age found at an average depth of about 7,000 ft. The main pay sections are an upper sand about 30 ft. thick, productive over most of the field, and a lower sand about 25 ft. thick productive over part of the field.

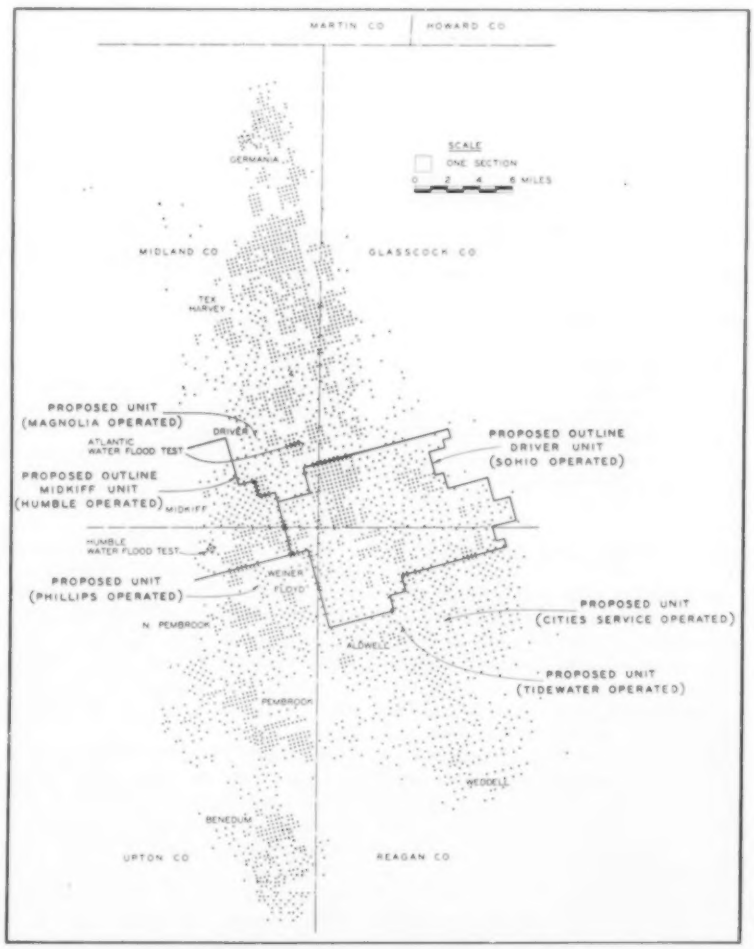
Spraberry sands are very tight, less than 1 md., and would not produce at a commercial rate if they were not highly fractured in a vertical fracture system covering the entire field. These fractures, which are present in nearly all cores, are extensive, as proved by reduced pressure observed in new wells at distances up to 1 or 2 miles from producing wells and by results of pilot water floods. The time lag of pressure and production decline and shut-in wells ¼ to ½ mile from producing wells is only a few weeks.

Author is manager of production research for Sohio Petroleum Corp., Oklahoma City. Paper presented at annual meeting of National Oil Scouts and Landmen's Association, Tulsa.

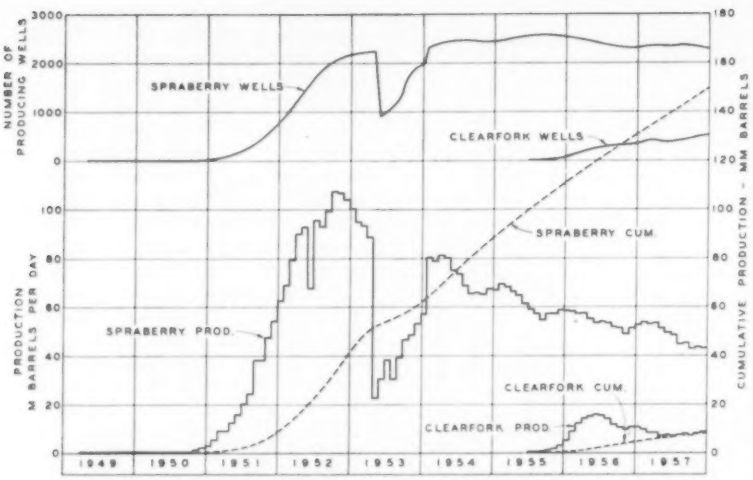
Production declined . . . Cumulative production of the Spraberry Trend area was 150,000,000 bbl. and production rate had declined to 42,900 bbl. per day in December 1957. The field performance history is shown in Fig. 2. Decline of field-wide production of only 60% over 5 years is deceptive because the decline has been retarded by moderate development of an additional 1,000 wells during this period. Individual wells and leases have declined more. Production now averages only 19 bbl. per well per day and many wells produce little or no oil. More than 185 wells have been abandoned in the older Tex Harvey-Germania area and 260 more plugged back to the Clearfork.

Low Primary Recovery

Core data indicate oil in place to



SPRABERRY AREA, showing proposed units. Fig. 1.



PRODUCTION HISTORY, Spraberry trend field and Benedum field. Fig. 2.

be about 6,000 bbl. per acre in the upper Spraberry and maybe half that much in the lower zone. Cumulative recovery averages only 500 bbl. per acre or 6 to 8% of oil in place.

Capillarity . . . Reservoir engineers think that low recovery is caused by capillary retentive forces accentuated by the large number of fractures in this low-permeability sand. These fractures are a mixed blessing: they permit production from a reservoir too tight to produce through the rock matrix; but, they modify capillary forces to restrict primary recovery to maybe a third of what it might have been in an unfractured sand having higher permeability.

Pilot water flood . . . Atlantic Refining Co.'s research engineers visualized a new approach to water flooding tight fractured sands such as the Spraberry. Simple laboratory tests, such as submerging oil-saturated core fragments in a tumbler of water, showed the blotter action of the sand would absorb water preferentially, even to the extent of displacing a reasonable fraction of the oil out of the sand. Calculations led to the conclusion that the process would work in the reservoir and Atlantic's management backed this faith with a field pilot test in the central Driver area.

Starting in November 1952, water was injected into three wells as shown in Fig. 3 which comprised part of a normal five-spot pattern. Injection rates reached 650 to 700 bbl. per well per day by gravity flow. The test was terminated August 1, 1955, after 1,477,000 bbl. was injected. The decline in production of a number of wells was arrested and the producing rate was increased in a few. Gas-oil

FIG. 3

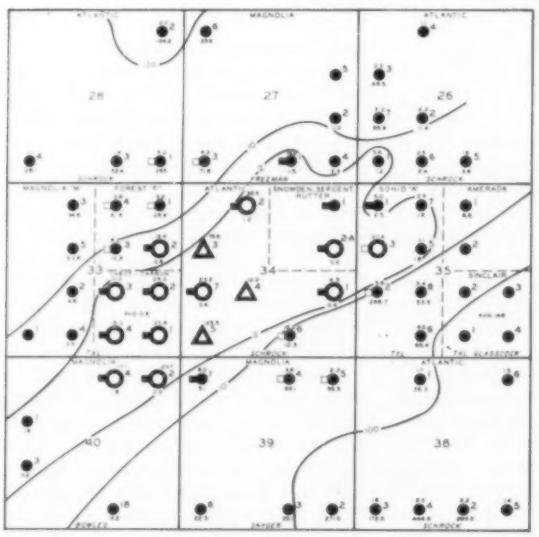


FIG. 4

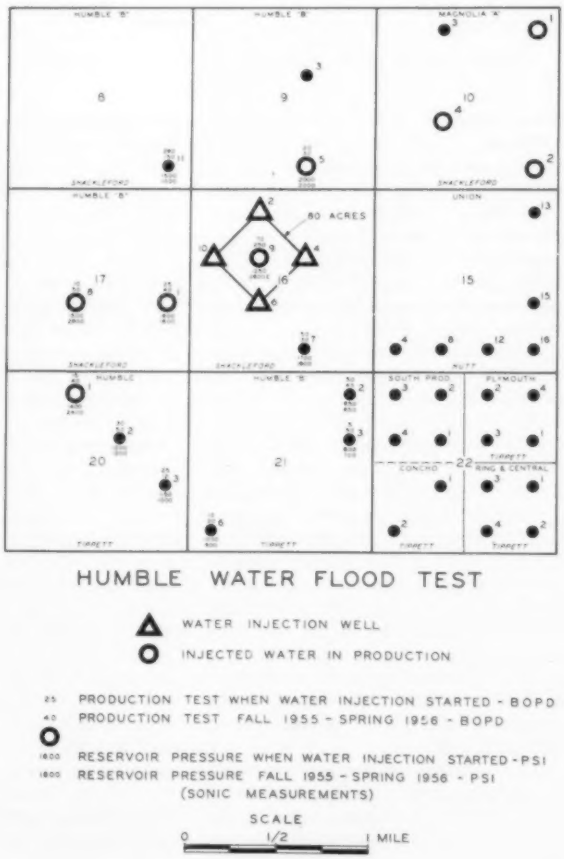
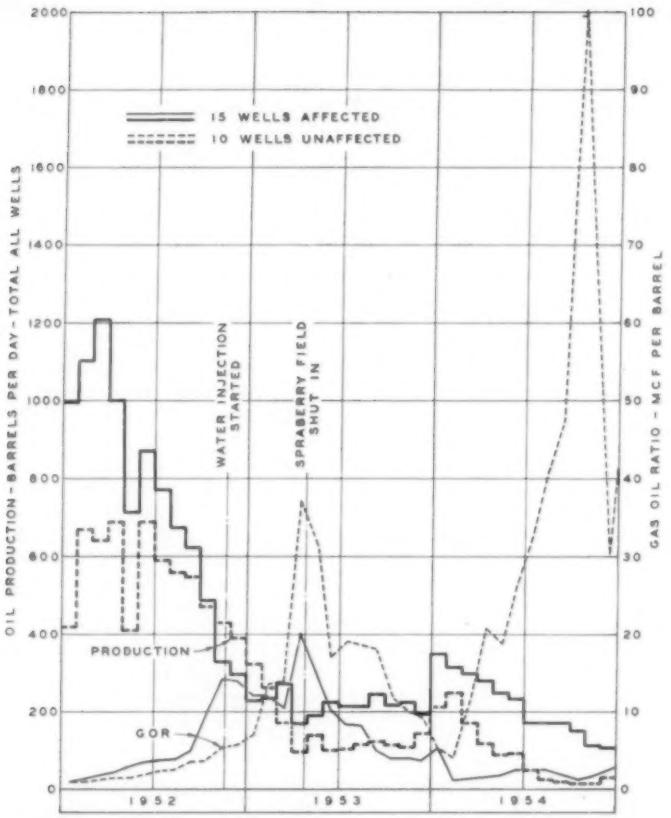

80 ACRES
HUMBLE WATER FLOOD TEST
WATER INJECTION WELL
INJECTED WATER IN PRODUCTION
PRODUCTION TEST WHEN WATER INJECTION STARTED - BOPD
PRODUCTION TEST FALL 1955 - SPRING 1956 - BOPD
RESERVOIR PRESSURE WHEN WATER INJECTION STARTED - PSI
RESERVOIR PRESSURE FALL 1955 - SPRING 1956 - PSI
(SONIC MEASUREMENTS)
SCALE
0
1/2
1 MILE

Fig. 5.



COMPARATIVE PERFORMANCE of wells in Atlantic water-flood test.

ratios declined from the range of 4,000 to 125,000 cu. ft. per bbl. to less than 2,000 cu. ft. per bbl. in 18 wells in a northeast-southwest trend from the water-injection wells. These low ratios contrast sharply with gas-oil ratios typically 10,000—300,000 cu. ft. per bbl. in nearby wells northwest and southeast of this trend during the test period.

Injected water appeared in modest quantities in 11 producing wells and in large volume in only 1 producing well during the test. This water production conforms closely to the pattern of greatly reduced gas-oil ratios. Together they outline an approximate 1,000-acre area presumed to have been affected by the water injection. Ultimately 1.4 million barrels of water was injected in the area, or about 1,400 bbl. per acre. This contrasts sharply with the 50 to 100 bbl. per acre fracture volume estimated but compares favorably with the 1,100-1,300-bbl. per acre gas space in the formation created by oil production and shrinkage.

This volumetric comparison indicates beyond any reasonable doubt that water went into the rock matrix and the significant reductions in gas-oil ratios indicate the fractures must have become highly resaturated with oil. Fig. 5 outlines composite performance of 15 wells most affected by water injection and 10 other test wells judged to be unaffected. Following 75% decline in production in the last 9 months of 1952 the affected wells stabilized at 200 to 300 bbl. oil per day total in 1953 and first half of 1954.

The most significant production increase occurred in Magnolia Petroleum Co. 2 Bowles, southwest diagonal offset to two injection wells. This well changed from about 30 bbl. oil per day to about 60 bbl. oil per day in 6 months. Significant water breakthrough occurred in only one well, Magnolia 4 Bowles, which changed rapidly from about 60 bbl. oil and 4 bbl. water per day to 30 bbl. oil and 100 to 130 bbl. water per day.

The unaffected wells stabilized at about 10 bbl. oil per well per day following the Spraberry shut-in in April 1953. They declined rapidly during 1954 when production of all wells in the area was resumed.

More study . . . Starting with the concepts developed by Atlantic, and benefiting from their Spraberry pilot water flood, Humble Oil & Refining Co.'s production research division extended study of behavior of flooding fractured reservoirs. It discovered a feature not previously reported in the literature. It's work centered on performance of fractured reservoir blocks as influenced by dynamic effects of water moving in the fractures. Atlantic's research had involved static water in the fractures.

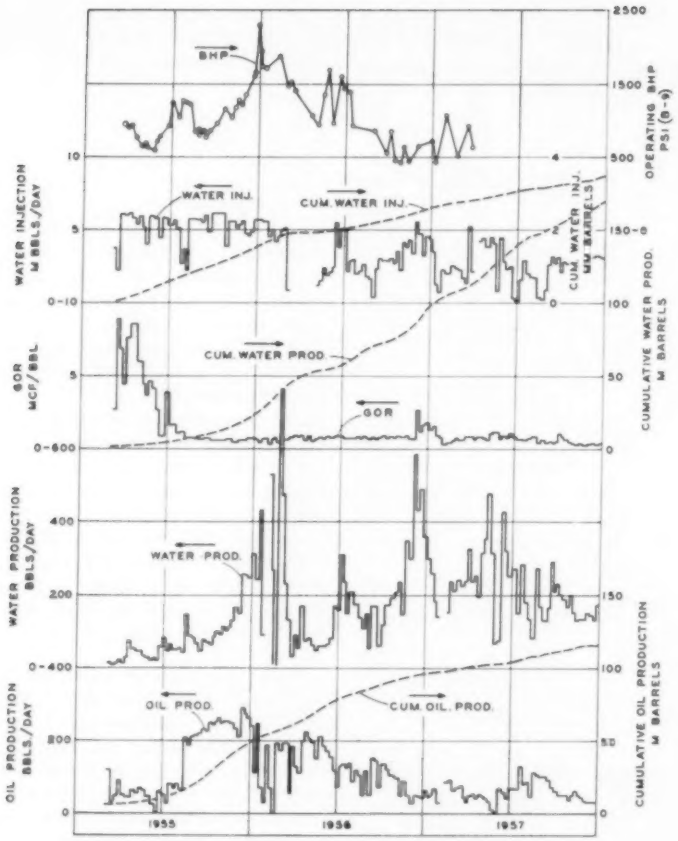
Humble found in the laboratory that strongly water-wet fractured sands could be water flooded effectively if there were sufficient crossfractures oblique to the general direction of flow. In effect the various fractured segments are flooded simultaneously and the oil production from them is additive.

Requirements essential for successful displacement of oil by this process are: (1) the formation must be strongly water-wet; (2) there must be a large number of crossfractures to provide multiple water-entry points; and (3) the fluid-flow capacity of fractures in the primary direction of flow relative to the fluid-flow capacity of the rock must be low enough to permit all the water to enter the matrix of the fractured sand blocks in a distance much less than the spacing between injection wells and producing wells.

And another test . . . Believing that all of these requirements exist in the Spraberry, Humble started a pilot test in the Midkiff area in March 1955 using wells as outlined in Fig. 4. The producing well in the center of the test was newly drilled in this somewhat depleted part of the field. Its productivity declined rapidly from 377 bbl. oil per day initially in January 1955 to 70 bbl. per day in March 1955 when water injection started and its gas-oil ratio had increased to 8,000 cu. ft. per bbl.

Detailed performance of this well is illustrated in Fig. 6. Injection of 1,500 bbl. water per day into each of the four wells surrounding the test well caused very rapid reduction of gas-oil ratio to 700 cu. ft. per bbl. by August 1955 and stabilized the production rate at more than the capacity of the pumping equipment installed. A larger pump was installed and oil production increased to and remained near 250 bbl. per day through the rest of the year.

Oil production declined from 200 bbl. per day in May 1956 to about 10 bbl. per day recently as water percentage continued to increase. Water injection was stopped in the spring of 1958 when 3,800,000 bbl. had been injected and the test was terminated. At that time the center test well had



WATER-FLOOD performance in the Humble test. Fig. 6.

produced 118,000 bbl.—nearly 1,500 bbl. per acre for the 80-acre pilot test. A large percentage of this recovery is attributable to the water flood since the well was drilled into the semidepleted area and probably had remaining primary reserves of not more than 100 to 200 bbl. per acre.

Tests compared . . . Water flooding at rates sufficient to restore reservoir pressure increased oil production to 250 bbl. per day. This is in sharp contrast with the similar Atlantic field test where fluid withdrawals in excess of water injection caused reservoir pressure to decline in all producing wells. The reaction of this Humble test well to pressure restoration is in agreement with the conclusion reached from the Atlantic pilot test data. That is, the fractures are pressure sensitive and will close as the reservoir pressure declines, but will open again on pressure buildup. Production data of Humble observation wells outside the pilot five-spot also confirm this pressure-production relation. Oil-production rates and reservoir pressures of these wells measured before and during the water-flood test are included on Fig. 4.

In general the wells northeast and southwest of water injection showed a significant increase in production and experienced either stabilization or increase in reservoir pressure. Wells northwest and southeast of injection continued to decline in both oil production rate and in reservoir pressure.

Invasion of injected water into producing wells, identified by chemical analysis, was also limited to wells in the northeast-southwest trend. The combination of increase in oil-production rate, increase in reservoir pressure, and invasion of injected water shows the direction of the Spraberry fracture system.

What it will cost . . . Additional investment will be about $135,000 per section with flooding on 160-acre spacing. These costs assume conversion of many wells to water supply, but do not include the costs of new wells which may be required in some of the underdeveloped parts of the Spraberry. Total operating cost including water supply, oil production, and all overhead features will average about $2,500 per section per month when maximum injection and production are reached. With prospective recovery of 1,500 bbl. per acre, operating profit is forecast to range from $1,400,000 to $2,000,000 per section or $10.00 to $14.50 profit per dollar invested with the range depending upon oil-production rates achieved during the flood.

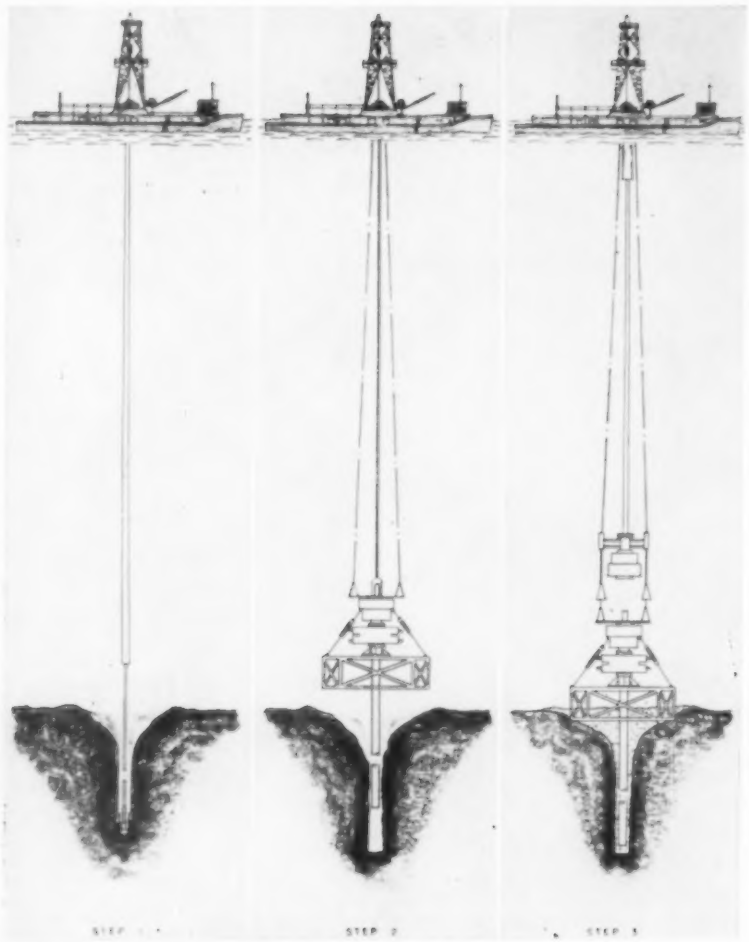
Flood water available . . . Volumetric analysis of the San Andres from gamma ray, neutron, and electric logs indicates adequate water volume will be available to flood the entire Spraberry, and well tests indicate adequate rate capacity.

Unitization attempted . . . Recognizing the pending abandonment of many Spraberry wells which are approaching economic limit, Sohio Petroleum Co. undertook the task of attempting unitization of a very large part of the Spraberry. Operators of properties within many miles of Sohio's 21-section Driver area were invited to a meeting in Midland on September 25, 1957, to hear the proposals. Committees were formed and studies were made of the technical, economic, business, and legal questions involved. The progress made in the ensuing 8 months has been excellent. Nearly 90% of working-interest owners in a 100-section area have tentatively agreed to unit participation. The boundary of Sohio's proposed unit is outlined on Fig. 1.

Many additional large Spraberry water-flood units may be organized. One of these, west and northwest of the Sohio section, is being sponsored by Humble. The first meeting of operators in that area was held April 22, 1958. Committees were formed and the various studies directed toward unitization are now in progress. Other operators have indicated their desire to organize and operate units in other areas contiguous with the proposed Sohio unit. These include Cities Service Oil Co. to the southeast, Tidewater Oil Co. to the south, Phillips Petroleum Co. to the southwest and Magnolia to the northwest. While these latter unitization efforts have not reached the organization stage it is quite likely that most of these units will be formed and the Spraberry flooded.

There is a pressing necessity of early action since so many leases are at or near the economic limit of primary operation. If too many wells are plugged, the field will never be redrilled and water flooded and all owners, royalty and working-interest alike, will be the losers. All concerned should recognize this urgency so that they may be tolerant in their negotiation of factors involved in the voluntary water-flood units.

Fig. 1



Its originators claim that a new technique permits

OFFSHORE drilling for ONSHORE prices

BY R. F. BAUER, A. J. FIELD, AND HAL STRATTON
Union Oil Co.

DRILLING into submerged lands from a floating vessel is now a reality. Inevitably, this new drilling technique will have a profound influence on the future of offshore drilling.

Stop for a moment to ponder the significance of the development of this technique (Fig. 1):

1. An exploratory drilling and testing program, core-hole program, or a stratigraphic program can be conducted over submerged lands at a cost comparable to onshore costs.

2. Such a program can be conducted on lands covered by several hundred feet of water and again at costs to compare with onshore experience. Vast new areas of geologic promise are brought into economic range.

Surely there will be many applications for this tool throughout the world. The future may indicate the possible shifting of emphasis from desert, jungle, ice, or muskeg to submerged lands in view of the economy to be found in wildcatting.

Authors are with Union Oil Co. of California, Los Angeles. This paper presented at the spring meeting of the Southern District Division of Production, API, under the original title: "A Method of Drilling from a Floating Vessel and the CUSS I."

It seems further inevitable that it is just a question of time until these techniques are being used to complete wells on the ocean floor.

The group of four companies known as the CUSS Group—Continental Oil Co., Union Oil Co. of California, Shell Oil Co., and Superior Oil Co.—has been responsible for the development of this new method of drilling. The group was formed to jointly explore the California submerged lands.

Early exploratory efforts were principally geophysical. This was followed by taking surface soil samples and finally near-surface cores. The techniques of taking surface cores with a dart and with the use of the jetting tool were developed by the group. Some cores were taken using drill pipe. In this case the pipe was rotated and salt water was used as a jetting fluid.

The complexity of California geology made it more and more apparent that a better exploratory tool was needed. The desire to acquire geological information at greater depths led to thinking of ways or means that might permit the application of conventional drilling practices. A new method of drilling was designed which permitted drilling from a floating vessel incorporating the normal drilling practice of return circulation, the use of blowout-prevention equipment, and hole reentry.

History . . . The first floating drilling experiments were performed in 1953. The M. V. Submarex (Fig. 2), a 300-ton ex-Navy patrol craft, was equipped with a small drilling rig and experiments were performed to develop a method of drilling from the vessel. By 1954, the art of this type of drilling, which incorporated the features of hole reentry—return circulation—and blowout prevention, was reduced to a practical exploratory method. Several hundred thousand feet of core holes have since been drilled in submerged lands in water depths ranging from 30 to 400 ft. Experience thus acquired led ultimately to the design and construction of a much larger tool of this type; viz., the drilling barge CUSS I.

Engineering on the CUSS I started early in 1955 and culminated with its eventual completion in late 1956. It has successfully drilled in 45 to 350 ft. of water to depths ranging from 3,000 to 6,000 ft., performing all the usual operations undertaken in a drilling well such as coring, fishing, and

Why drill from floating vessel?

- This method of drilling may be used in almost any water depth. Drilling has been commonly practiced in depths of 200 to 400 ft. at costs that are comparable with onshore exploratory-drilling operations.
- The portability of this type of equipment minimizes offshore-drilling costs. The barge may be towed or propelled over long distances as a stable, seagoing vessel without the necessity of disassembly and reassembly required of other drilling structures. Therefore, there are no locations to grade, no platforms to erect, no roads to build, and no rigup time is required.
- Using this technique, the drilling barge may be designed and sized to fit a drilling program. This is contrary to the more conventional offshore practice where fixed platforms must be sized in accordance with water depth. Capital investment is, therefore, related directly to the drilling-depth requirement and not to water depth.
- Although the initial rig investment and the cost per day is generally considerably higher than onshore, the actual cost per foot of hole is, at least, comparable as a result of the foregoing.
- A properly designed floating drilling barge is very stable. Under adverse weather conditions it simply becomes a seagoing vessel. California experience indicates that the method may be adapted to any ocean bottom.
- The capsizing of some of the barges and platforms in the Gulf Coast has been attributed to scouring at the ocean floor. This, of course, is not a factor with the floating barge.
- Blowout-prevention equipment is used in the conventional manner. In addition, large quantities of mud may be carried on the barge without the concern of load limitations inherent in the fixed-type platform.
- Cellar depth or head room certainly does not limit the number of blowout preventers that may be used.
- During adverse weather the wellhead may be left secure on the ocean floor where it is not in any way subject to the forces of the storm.

electric logging, including continuous dipmeter and sidewall sampling.

CUSS I and equipment . . . This barge (Fig. 3) is a converted ex-Navy YFNB barge, 260-ft. long by 48-ft. beam by 15-ft. moulded depth (main deck to keel), with a 22 by 32-ft. diamond-shaped hole in the center (Fig. 4). The barge has three working levels—the hold, main deck, and house top deck, giving over 30,000 sq. ft. of usable space for drilling machinery, storage, pipe racking, and crew quarters. Spacious living quarters permit the berthing of 36 men. A recreation room complete with television, radio, and lounge furniture makes shipboard life more enjoyable. There are separate offices for the tool pusher and captain, as well as a radio and radar room.

Six diesel-driven mooring winches, three on the bow and three on the stern, serve to anchor the barge to six mooring buoys (Fig. 5). Each winch has 1,800 ft. of 1¼-in. wire line which passes through a sheave on each of the six mooring buoys and is dead-ended at the barge. One-and-one-half-inch Di-Lok chain with a scope of at least 5 to 1 is run from each of six 7,500-lb. Danforth-type anchors to the mooring buoys.

A special 98-ft. derrick with a 32 by 40-ft. base is mounted on two large tied arches which, in turn, have been pin connected to the hull at the forward end and pin connected to a special slide footing at the aft end, thus minimizing the bending stresses in the hull. The derrick is designed for a 550,000-lb. hook load.

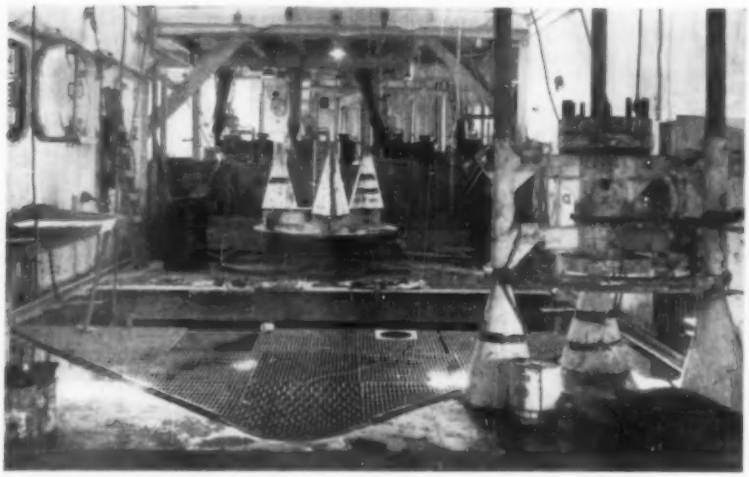
It has the ability to withstand a 30° roll in an 8-second period with 160,000 lb. of drill pipe in the derrick. Although presently 98 ft. high, the design permits adding another section to attain a height of 142 ft. The tied-arch construction gives 20 ft. of clearance under the rotary table, which materially assists in the handling of blowout-prevention and wellhead equipment, and eliminates many costly hours of rigup time.

The draw works is a modified National 80-B with a four-engine National drive group. Four Cummins VT-12 turbocharged engines driving through Torcon 19 BK torque converters, supply 1,750 hp. to the draw works, rotary table, and two National 8 by 14-in. G-700 mud pumps.

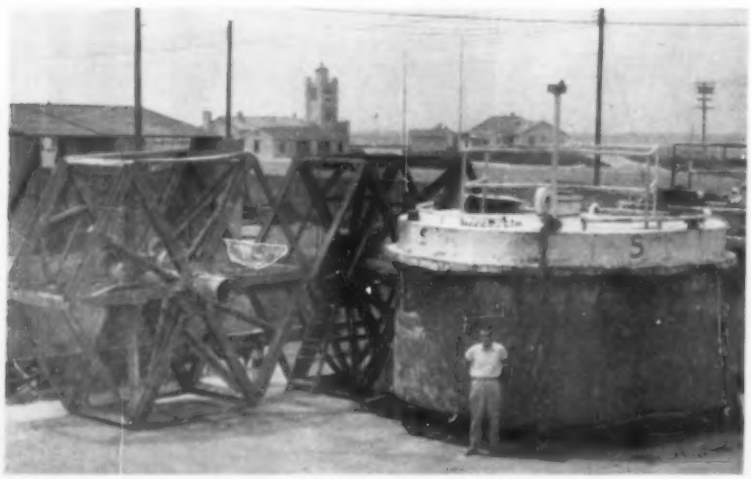
The rotary table is an Ideal MS-27½-in. table, driven from a right-

EXPERIMENTATION was carried out on converted Navy patrol vessel, operating in 400-ft.-deep waters. Fig. 2.

CUSS I has drilled over 100,000 ft. of hole since late 1956. Fig. 3.



DIAMOND-SHAPED HOLE is below the gratings. Bottom cone assembly, center, and a portion of conductor holddown assembly, right foreground, are also shown. Fig. 4.



SIX MOORING BUOYS, similar to the ones here, anchor the barge. The hexagonal-shaped objects are the ocean-bottom-landing bases. Fig. 5.

angle drive from the draw works. It is fixed with respect to the barge, and all gimbaling takes place in the master bushings and kelly bushings. The rotary table may be quickly disconnected and the entire unit skidded to one side leaving an opening of 8 by 10 ft. through the derrick floor.

The mud system consists of 1,600 bbl. of rotary mud which is continually agitated. In addition to the above storage, approximately 4,600 bbl. of drilling water or mud storage exists. The mud ditch, 120-bbl. working tank, and Medearis type-L double shaker are housed in a gas-tight and ventilated room, thus minimizing hazards caused by gas-cut mud.

Mud mixing may be accomplished by one of two methods: a Medearis mechanical mixer, or a jet hopper system utilizing one of the two slush pumps or the cementing pump. One hundred tons of pelleted sack mud, handled with a fork lift, are on hand at all times. The unique three-level relationship between draw works, drive group, and mud pumps makes it possible to properly place the working tanks to attain maximum hydraulic efficiency. The pumps have a 15-ft. flooded suction.

The crown block and 300-ton traveling block have 48-in. diameter sheaves to minimize line wear. The traveling block is a Baash-Ross-type DMB combination block and a Byron Jackson hook modified to permit stabilizing the blocks by the use of heavy guide rails (Fig. 6) with extension-spring bumpers to absorb lateral loads imposed on the block by the roll of the barge.

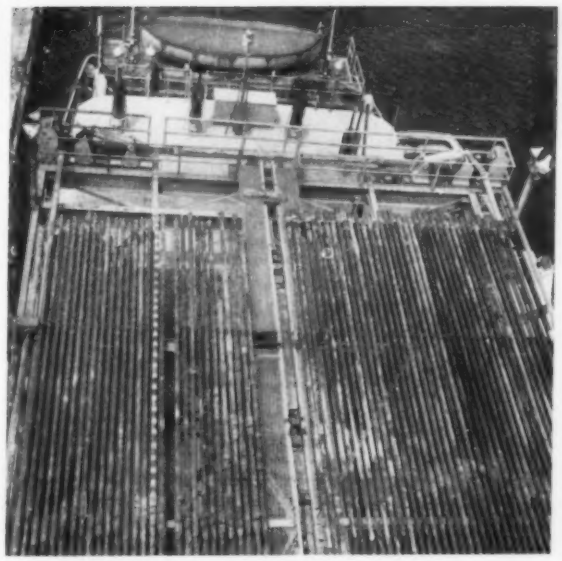
Stands of drill pipe are pulled and laid down in doubles (Figs. 7 and 8). The pipe racker is capable of handling 8,500 ft. of 5⅞-in. o.d. drill pipe or any smaller size desired. All controls are pneumatically operated, and are supplied with air by a Model M 40 Ingersoll-Rand air compressor. The complete unit permits round tripping as rapidly as on land.

A separate casing rack accommodating approximately 7,000 ft. of 9⅝-in. casing is forward of the rig floor (Fig. 9). Two hydraulically operated high lines serve both racks to give complete control of each joint of casing.

Casing and other supplies may be readily loaded from auxiliary vessels by use of a 6/10-yd. pedestal-mounted crane adjacent to the pipe rack.

The cementing unit is a Halliburton AC skid unit. All cementing is handled in pneumatic pods, thus minimizing wastage and greatly increasing the operating efficiency. Storage facilities on the barge and on the auxiliary vessels total 900 sacks of cement.

GUIDE RAILS stabilize the traveling block. The large-diameter sheaves minimize line wear. Fig. 6.



DRILL PIPE is handled automatically by means of specially designed pipe-racking facilities. Fig. 7.

All cementing and mud manifolding piping has Series 1500 fittings and is crossmanifolded to give maximum flexibility of operation.

A Hydril 80-gal. automatic pump accumulator supplies a four-station control manifold. All hydraulic control lines between the control manifold and the blowout preventers are high-pressure steel-reinforced wire-braid hose. For ease of handling, both hydraulic lines and kill-line hose are spooled on pneumatically powered drums.

Two complete closed-circuit, underwater-television units have been installed to inspect wellhead connections.

Barge auxiliary equipment includes three 100-kw., d.c. generators; a 300-gal.-per-hour vapor-compression distillation unit for potable water; and normal ship's services such as fire, bilge and sanitary pumps, ship's air supplies, and a welding machine. Fuel-oil storage totals 60,000 gal. and lube-oil storage is 5,000 gal.

Method of drilling . . . The method of drilling used by the CUSS I is described in the following steps (Fig. 1):

1. The barge is towed to the location where moorings have been preset. The "bird cage," or landing base, is suspended on wire lines in the center well of the barge. The bird cage serves as a foundation or landing base for support of the casing strings and wellhead equipment on the ocean floor. Surface pipe is then picked up, run through, and temporarily landed on the bird cage. Just enough pipe is run to permit it to hang free in the water and not touch the bottom.

The drill string is then made up and run through this amount of surface pipe to the ocean floor, at which point the hole is spudded and drilling proceeds using salt water as the circulating fluid. The system of circulation is not closed at this point. An underreamer is used in this drill string; and as the hole is drilled, it is underreamed to a diameter that will permit running the surface pipe.

2. When sufficient hole has been drilled to set the surface pipe, it is common practice to flush this hole with rotary mud. Old mud that is about ready for disposal is usually used. The surface pipe is then lowered into registry with the hole by stripping on another joint of casing. The drill pipe is then withdrawn and the additional casing, if any, is made up to complete the surface string.

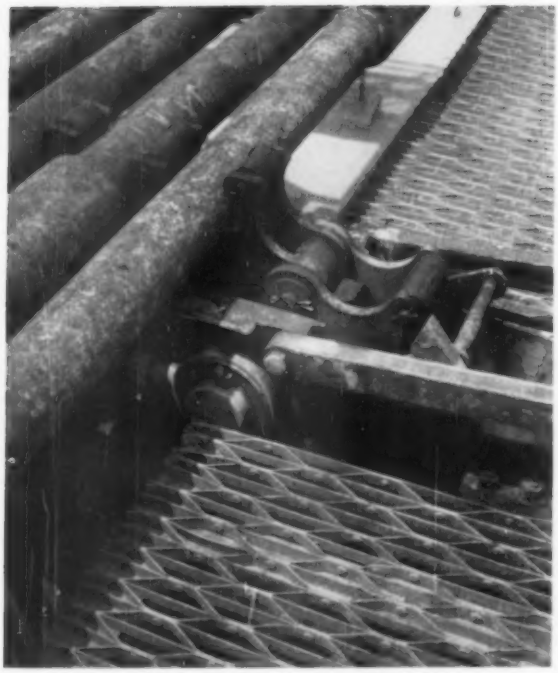
The pipe is then landed on the bird cage and one or more blowout preventers are flanged on the top. A mandril is flanged to the uppermost blowout preventer, together with a system of three cones to which are attached guide lines. The mandril is equipped with pins or lugs which are used in connection with a J-slot setting tool attached to the end of the drill pipe. Using the drill pipe, the whole assembly is lowered into position with the bird cage resting on the ocean floor.

As an alternative, this assembly could be lowered with the guide lines. A stinger of pipe equipped with a swab cup protrudes inside the surface pipe below the J-slot setting tool. When the bird cage has been set in position on the ocean floor, the setting tool is disengaged leaving the stinger and swab cup still in the surface pipe and the latter is cemented in place.

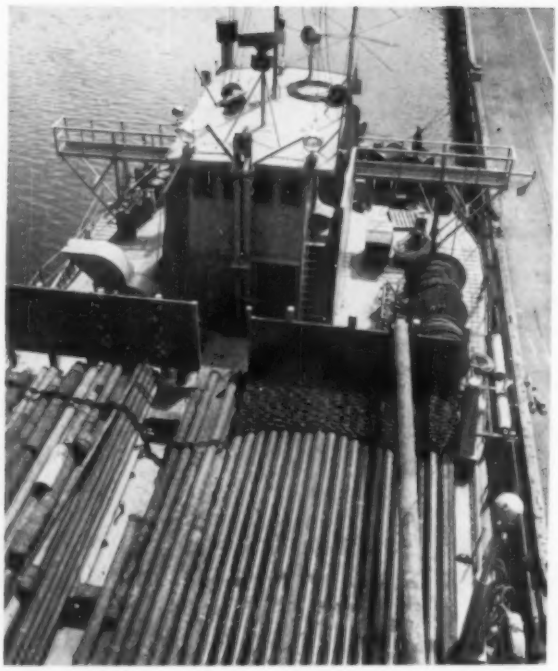
In some instances, depending upon local conditions, it is desirable to use a considerable excess of cement which flows up the annulus between the casing and the hole and has a tendency to mushroom around the steel framework of the bird cage; thus a foundation is formed which will withstand the imposition of considerable vertical or lateral force.

3. The drill pipe is then withdrawn. A conductor pipe is then made up and flanged to the top of a bag-type blowout preventer. A guiding assembly is attached to the body of this blowout preventer through which the guide lines are reeved and which incorporates a system of three cones which are designed to readily register with the three cones that were formerly run adjacent to the mandril. Additional amounts of conductor pipe are made up and lowered until the blowout preventer on the bottom is guided and lowered into registry with the mandril.

Just prior to making up the last joint or two of the conductor pipe, a so-called flotation tank is stripped onto the conductor. This is simply a cylindrical tank with a hole sufficiently large through the center to permit passage of the conductor pipe. Lugs on a collar of the conductor pipe permit the pipe to be rested on the top of the flotation tank.



EACH JOINT OF PIPE is individually confined in the specially designed pipe rack. With these automatic units, round trips are as rapid as on land operations. Fig. 8.



CASING RACK, office cabin, and bridge are located on the top foredeck along with the blowout-preventer control center with reels for control lines and kill lines. Fig. 9.

The buoyancy of this tank is controlled by forcing air in or out of the tank. Normally the tank is positioned on the conductor pipe just below the hull of the vessel and has sufficient buoyancy to support the full weight of the conductor pipe and, in fact, to maintain some tension in it at all times. Essentially the installation of this apparatus brings the hole up to the bottom of the vessel.

At this point a slip joint is flanged to the top of the conductor pipe to account for motion of the vessel as it rises and falls with the swell. It further extends the conductor pipe to a sufficient height to permit the mud to overflow through the pitcher nipple and gravitate through the mud system to the pump suctions.

4. From this point on the drilling operations proceed in a more or less conventional manner. It is customary to incorporate a bumper sub properly located in the drill string.

5. One or more additional strings of casing may be run when this is desired. There are several ways this may be done.

6. It has been common practice to core or sidewall sample and run the various logs that are available. Core holes that have been drilled to date by the CUSS have been subsequently cemented and abandoned in accordance with the requirements of the State of California, and the ocean floor equipment has been recovered for reuse. It has proved to be important on past occasions under storm conditions to release the surface-conductor hydraulic holddown. This permits the detachment of the vessel from the wellhead except for the guide lines and hydraulic actuating lines, both of which are extremely flexible, but could be buoyed and cast off if necessary.

Performance . . . This basic method of drilling from a floating vessel, as described in the foregoing paragraphs, may be modified in many minor particulars.

Following the development of this technique by the CUSS group, several companies equipped vessels and put them to work core drilling in the California offshore. In fact, there have been as many as 10 core-drilling vessels in operation at one time in California waters. It is estimated that well over a million feet of hole have been drilled using this basic method. The CUSS I barge has drilled in excess of 100,000 ft.

All the procedures followed in drilling from CUSS I are exclusive of the need for divers. Although divers were used quite extensively during the development of the technique, they are now only used occasionally to recover lost equipment or for the purpose of observation. When this type of equipment is used to complete oil wells on the ocean floor, divers will no doubt be used quite extensively and can be used effectively in considerable water depths.

Very little lost time has been experienced in the operation of the CUSS I as a result of weather conditions. It has now operated through two of the West Coast's bad-weather seasons.

The CUSS I has operated in water depths ranging from 45 to 350 ft. and has drilled holes up to 6,200 ft. deep.

The barge has most recently been used on two exploratory programs. In the first instance, eight core holes were drilled to an average depth of 5,000 ft. The average time required to complete and abandon each core hole was 12.8 days. The average time to reach the total depth in each instance was 10 days.

More recently the barge has drilled eight core holes to an average depth of 3,530 ft. The average time to complete each core hole was 6.6 days.

It is thus apparent that penetration rates compare favorably with onshore experience. Further, the drilling times indicated are calculated on a continuous basis; viz., dividing the total elapsed time by the number of core holes drilled. Therefore, in comparing this with onshore cost experience, moving time, road building, and site preparation must be considered in onshore estimates.

Gas Chromatography—

Powerful new tool for chemical analysis

Vapor chromatography is a relatively new type of instrumentation based on adsorption and partition principles. It provides excellent analytical results for gases and liquids with boiling points as high as 400° C.

(Part 1 of 4 Parts)

BY H. H. HAUSDORFF and N. BRENNER
Perkin-Elmer Corp., Norwalk, Conn.

THE METHOD consists of carrying a mixture of components through a column by means of a carrier gas. The components arrive separately at the exit where they are measured by a suitable detector.

Recordings obtained by measuring the detector output thus result in a series of peaks. The peak location or characteristic component speed provides the qualitative information. The peak heights or areas can be used successfully for determining per cent concentration.

The method has particular advantages such as low cost, simplicity, ease of data interpretation, little or no interference between components, high sensitivity in trance analysis, and over-all good quantitative accuracy with small sample quantities (1-10 mg.)

How Did It Get Started?

Chromatography practically originated in 1906 from work done by a Russian botanist, Tswett, who applied the principles of adsorption to the separation of coloring matters of leaves. The nomenclature "chromatography" was suggested by Tswett since the technique produced separation of colored substances. Possibly the name of Tswett, which is the Russian word for color, may have also contributed to this nomenclature.

The work was largely neglected until the 1930's when Kuhn, Winterstein and Lederer used this technique for the separation of carotenes and xantophylls followed by others who worked on inorganic separations.

In the course of a few years, chromatographic techniques have become indispensable tools for research work in almost every chemical laboratory, chiefly because they provide much higher resolving power in separation than many of the best distillation methods. The name "chromatography" has been retained throughout the years. It is felt that the term "fractometry" might be more suitable since separation and measurement of components is essentially the object of such techniques.

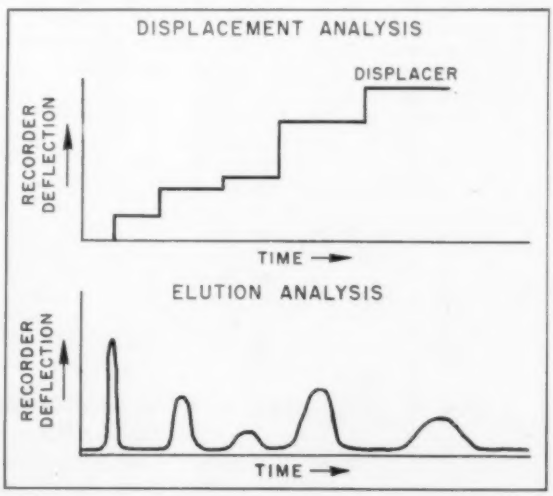
NOTE: This is part 1 of a 4-part series. Part 2 will deal with instrumentation techniques, part 3 with operating variables and part 4 with applications, in future issues of The Oil and Gas Journal.

Partition Chromatography

Before the introduction of liquid-liquid partition chromatography by Martin and Synge,[1] many attempts were made to separate gases and vapors by chromatographic methods using stationary solid adsorbents and a moving gas. The frequent occurrence of non-linear distribution isotherms, however, prevented clear cut separations and the technique never came into general use.

In their first paper on liquid-liquid chromatography in 1941, Martin and Synge suggested that separation of volatile materials should be possible by the use of columns having a stationary liquid phase and a moving gas phase. This suggestion, however, was neglected until 1951. Since then, many workers in England have developed this technique into a powerful analytical tool for analyzing volatile materials.

Work in the United States and Canada dates from 1955 but rapid progress has been made here, resulting in the development of advanced laboratory and process-control instrumentation. Gas chromatographic analysis is proving to be comparable in significance to spectroscopic and distillation methods for qualitative and quantitative chemical analysis. In addition, this method also promises to



IN DISPLACEMENT ANALYSIS the mixture to be analyzed is placed on top of the column and pushed through by means of a displacer vapor. Fig. 1.

have greater advantages in simplicity, efficiency and low cost.

What Are the Methods?

Chromatography essentially consists of passing a mixture through a column. It represents a two-phase system in which advantage is taken of the different equilibria existing between the two phases to separate components differing in equilibrium constants. The sample and carrier are generally called the mobile phase whereas the column material is referred to as the stationary (or static) phase. The mobile phase can be a gas, liquid or solid in solution whereas the stationary phase can only be a liquid or solid. From this, the following combinations can result and are generally dealt with as separate fields in chromatography:

1. Gas-liquid chromatography (partition)
2. Gas-solid chromatography (adsorption)
3. Liquid - liquid chromatography [partition (countercurrent)]
4. Liquid - solid chromatography (conventional chromatography) (ion exchange chromatography)
5. Solid - liquid chromatography. Same as 3 and 4, except that sample is in solution.
6. Solid-solid chromatography

This series primarily concerns the separation of components in the vapor phase and therefore only involves 1 and 2. These techniques differ depending on whether the column material is a liquid or solid.

Gas-Liquid Chromatography (Partition)

In gas-liquid or partition chromatography, the liquid which represents the effective stationary phase is spread as a thin film over a large surface area solid (such as Celite or Kieselguhr). This latter only acts as a support and should preferably have no adsorptive properties at all.

Components present in the mobile phase will partition between the vapor phase and substrate. The difference in the partition coefficient for each component provides the basis for separation.

Gas-Solid Chromatography (Adsorption)

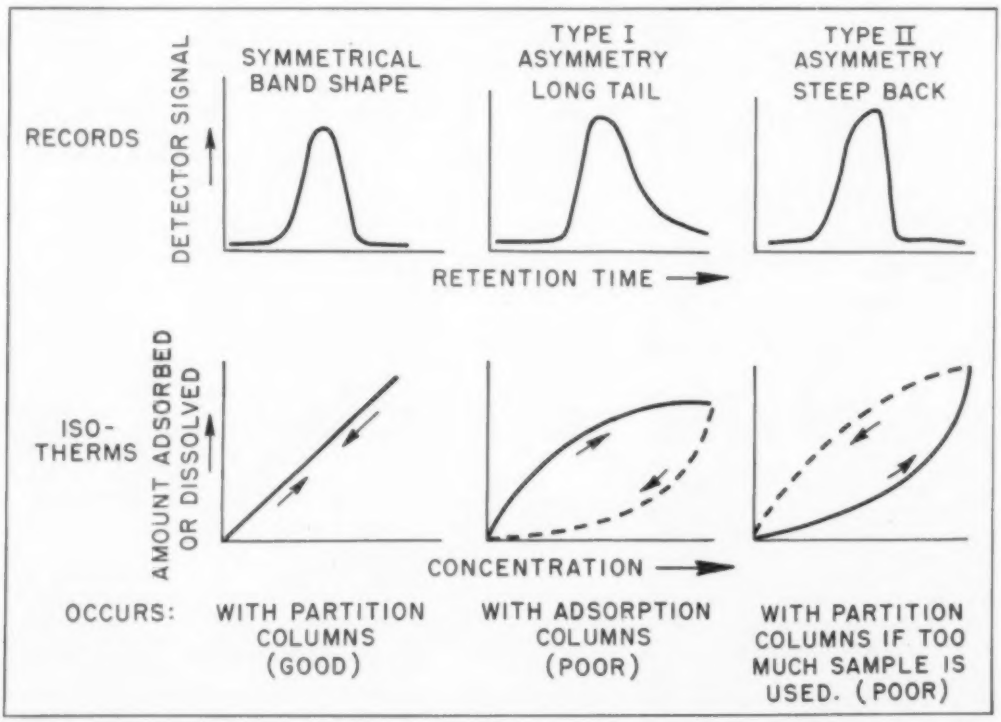
In gas solid or adsorption chromatography, the column is filled only with a solid adsorbent material (charcoal, alumina, silica gel, etc.). This material's fine pores and special surface will provide varying affinities for each component present in the mobile phase, and this is again the criterion for separation.

Another subdivision in methods arises from the different ways in which the components may be removed from the column. Here five techniques have generally been used. These are: displacement, frontal analysis, temperature gradient, elution, and gradient-elution analysis.

Displacement Analysis

In displacement analysis, the mixture to be analyzed is placed on top of the column and then pushed through by means of a displacer vapor. The displacer must be more strongly adsorbed by the column material than any of the components of the mixture. This method removes the various fractions from the column in the order of their increasing affinities for the column material. When the displacer appears at the exit, the operation is complete. The column can then be regenerated (freed from the displacer material) and used over again.

If a suitable detecter and recording system is placed at the exit of the column, a step pattern will be recorded (Fig. 1) where the distance of each step from the abscissa or zero line is a characteristic signal or property of the material and the step length for each component a measure of concentration. This method can best be applied to adsorbents as a column material. (Frontal analysis essentially gives a similar pattern and



THESE ELUTION RECORDINGS permit comparison of vapor-liquid elution (partition), vapor-solid elution (adsorption), and vapor-solid displacement (adsorption). Fig. 2.

only differs from displacement analysis in that the mixture itself is used as its own displacer. Temperature-gradient analysis, which consists of moving a heater along the column, will also yield similar pattern and results.)

Elution Analysis

In the elution technique the mixture to be analyzed is inserted into a continuous stream of carrier gas which moves the individual components through the column at different speeds depending on their respective retention by the column material.

Each component will therefore appear at the column exit at a definite time rate which is characteristic of that component's affinity for the particular column material. Such a column does not have to be regenerated after all the components have been eluted and is, therefore, ready for the next sample.

If a suitable detector and recording system is placed at the exit of the column, a series of peaks will be recorded (Fig. 1) where the peak location is a characterization of the component and the area under this peak (or peak height) a measure of its concentration. (Gradient-elution analysis combines the techniques of displacement with those of elution by using a continuously modified carrier which is impractical in vapor-phase chromatography.)

The differentiation in column material and in method of carrying the sample through the column will, therefore provide the following available techniques:

- Vapor-liquid elution chromatography (partition)
- Vapor-solid elution chromatography (adsorption)
- Vapor-solid displacement chromatography (adsorption)

To evaluate the respective advantages of these three methods, it is best to compare the behavior of adsorption and partition columns and the merits of displacement and elution techniques.

Adsorption columns . . . These have been found to be extremely useful for light-gas analysis but are less generally employed in analyses involving the separation of substances which are liquid or solid at room temperature.

Adsorption Columns—Disadvantages

The most serious one arises from irreversible adsorption. Components are generally rapidly adsorbed in the column, but cannot be as rapidly eluted from the adsorbent. This effect usually increases with decreasing vapor pressure of component. For higher-boiling materials irreversibility becomes so considerable that components cannot be entirely removed from the column within a reasonable length of time.

In some cases, irreversibility can be so serious as to result in no recovery of sample at all. This not only represents a serious threat to quantitative analysis but also affects qualitative analysis in that separation of the components is confused because of excessive length of tails of the recorded peaks or bands (Fig. 2.)

One of the criteria for obtaining symmetrical peaks in a chromatogram is that distribution isotherms governing the mobile and stationary phase equilibria are linear. Adsorption isotherms are generally of the Langmuir type and curve towards the pressure axis. This results in peaks which exhibit sharp fronts and tailing backs (Fig. 2).

The peak heights are not linear with concentration since most of the area increase is under the tailing portion of the band. Quantitative work, therefore, requires accurate integration under the peak. This cannot be obtained in a simple manner (such as multiplying peak height by half-band width) since considerable asymmetry does not permit simple area approximations.

Because of irreversibility, it can be expected that adsorption columns cannot be used indefinitely. Intermediate regeneration which might help this situation, is not always efficient and represents an added operation.

Adsorption columns are extremely slow compared to partition columns of similar resolution. While this is not intolerable for gases, it becomes significantly time consuming for low-boiling liquids and increasingly worse for higher boilers. Adsorption columns therefore, have to be operated at high temperatures even for low boilers and will be impractical for high-boiling materials.

Frequent column exchange implies that considerable time has to be wasted in flushing the columns until good detector balance is reached because atmospheric components are not as readily flushed from adsorption columns as from partition columns. This represents a serious time factor in routine laboratory work.

Some of these disadvantages can be reduced in selecting adsorbents of low activity or affinity such as silica gel.

Adsorption Columns—Advantage

The advantage of adsorption columns exists in the analysis of low-boiling and inert gases, which, since they move too rapidly through partition columns, might not be readily separated.

Partition columns . . . These have none of the previously mentioned disadvantages of adsorption columns. They usually provide symmetrical peaks similar to an ideal Gaussian error curve whose area can be approximated by assuming a triangular function. (Peak height multiplied by half-band width.) Where sampling volume input is constant or when internal standard techniques, the peak heights can be used instead of areas and will generally provide equivalent accuracy in quantitive analysis. Unsymmetrical band shapes sometimes encountered when columns are overloaded by too much sample (Fig. 2) can be eliminated by keeping the sample quantities small.

Partition columns are fast and provide great flexibility in separation of components with similar properties since care can be given to the choice of proper columns to benefit from solution forces and chemical interaction. This will be discussed later on.

Elution techniques . . . Although neglected for many years these have several advantages over displacement techniques. Operations here are considerably simplified since one does not have to switch to a displacer vapor and columns can be used over and over again. Separations are also more efficient since the components do not follow each other immediately.

Displacement techniques will not have the ability to distinguish between two immediately following components which happen to have the same for the particular detectors chosen, because a single line will be drawn for these two components in the displacement-step pattern.

This does not eliminate distinction of two components in the elution technique. If flow and temperature conditions should accidentally vary during recordings with the displacement techniques, these fluctuations will contribute extensively to quantitative errors and are liable to be overlooked. From an over-all point of view of data presentation in obtainable recordings, the elution technique seems to be much more preferable.

It is apparent that for general purposes the best accumulation of advantages can be obtained by combining elution principles with partition columns. This has been the most popular combination used.

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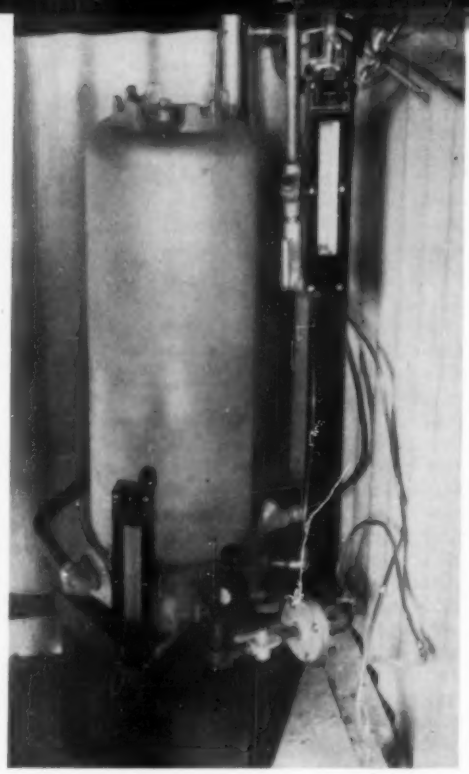


PETROCHEMISTRY

SEVERAL small temperature-controlled houses are used to shelter the various instruments located within the unit boundaries. At left are shown two optical analyzers and at right a gas chromatograph, all set up in one of the houses.

Texas Butadiene & Chemical Corp. plant makes

Good use of process analyzers

Infrared, ultraviolet, and gas-chromatography techniques are represented. Loss of valuable material is minimized in butylene and butadiene-recovery area. Isobutane to olefin ratio in alkylation charge is monitored.

BY DONALD M. WREYFORD
AND NOYES RICHEY
Texas Butadiene & Chemical Corp.

THE TEXAS Butadiene & Chemical Corp. plant near Channelview, Tex., was designed to produce 65,000 tons of butadiene and about 2½ million barrels of 115/145 performance-number aviation-grade gasoline per year.

In line with using the most modern equipment in all phases of production, the company has stressed automation in this plant. The wide use of process-stream analyzers is of particular interest.

- **Greatest need** for process stream analyzers is in the butadiene and butylene-recovery area. At several points in the system close control must be maintained to keep the butadiene loss down to a minimum.
- **Two infrared analyzers** are in the furfural absorber towers. The analyzers determine the butene-1 plus isobutylene concentration. The sample system on these analyzers is unusual in that it uses steam or water injection. A **third infrared analyzer** is on the butadiene purity rerun or finishing tower. These three analyzers are used with recorder-controllers.
- **Five ultraviolet analyzers** are installed in the butadiene-recovery area. These measure per cent butadiene in different concentration ranges. Three of these are used with recorder-controllers.
- **Two gas chromatography analyzers** are in use, one in the butadiene-recovery area, the other in the alkylation area. The butadiene-recovery-area analyzer takes samples from either one of two butylene splitter towers. An automatic switching device is used here. This chromatography analyzer records per cent of n-butane and of butadiene in an eight-component sample. The alkylation-area chromatograph was installed to sample total charge to contactors. Its function is to determine the isobutane/C_4-olefin ratio. It records isobutane, butene-1 plus isobutylene, and the cis and trans-butenes-2.

1. PROCESSING

The process consists of (1) catalytic dehydrogenation of n-butane to butenes and butadiene by the Houdry process, (2) recovery of butadiene and

Meet the authors . .

D. M. WREYFORD

NOYES RICHEY

Donald M. Wreyford is research physicist, manufacturing research laboratory, Texas Butadiene & Chemical Corp. He earned his B.A. degree in physics and math at Hardin-Simmons University in 1950. He was employed by Perkin-Elmer Corp. for 2 years prior to his present connection.

Noyes Richey has been employed by Texas Butadiene & Chemical Corp. since June 1956. He is currently a section head in the control laboratory and is responsible for spectroscopic and chemical analysis as well as process analyzers. He received a B.S. in chemistry from Southwestern Louisiana Institute in 1946 and has done graduate work at LSU. He was employed by Cities Service Refining Corp. in Lake Charles, La., from 1946 to 1956.

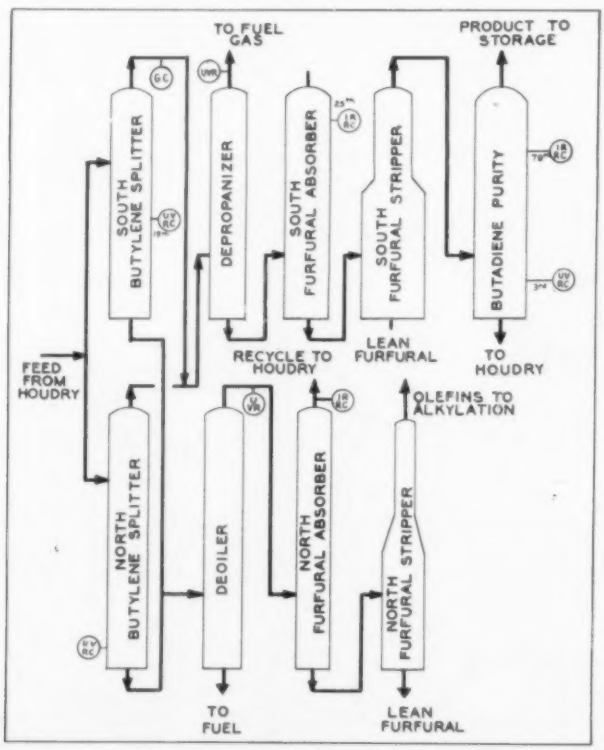
the concentration of butylene-containing streams by the use of fractionation and furfural extractive distillation, and (3) sulfuric acid alkylation of isobutane and butylenes.

Dehydrogenation

Commercial n-butane together with butane-butylene recycle stream is preheated and then reacted in fixed-bed catalytic dehydrogenation units at about 1,150° F. and 3.5 psia. The effluent gas from these reactors is immediately quenched with oil after which the gases are compressed in three compression stages to about 145 psig. The light ends are then removed in a conventional absorber - stripper cycle. The stripper overhead stream which contains propane, butanes, butenes and butadiene is then fed to the butadiene-recovery area.

Butadiene and Butylene Recovery

A normal distillation is the first step in the recovery and purification of the butadiene (see Fig. 1). Butylene splitters are used to separate the butane and heavier from the butadiene and lighter. The overhead product from the butylene splitters is then depropanized.



SIMPLIFIED FLOW DIAGRAM of butadiene recovery area with location of process analyzers indicated. Fig. 1.

Furfural extractive distillation . . . The butadiene in the depropanizer bottoms is separated from the butene-1 by extractive distillation using furfural as a selective solvent for butadiene. After stripping the butadiene from the furfural, it is redistilled to remove residual impurities. These impurities, principally butenes-2, are recycled to the dehydrogenation reactors.

The butene-1 concentrate (butadiene absorber overhead) is used as feed to the alkylation area.

The butylene splitter bottoms are deoiled to remove any heavy ends after which the butenes-2 are concentrated by furfural - extractive distillation. These butenes are then stripped from the furfural and used as feed to the alkylation area, or as recycle to the dehydrogenation reactors.

The overhead stream from the butylene absorber which is predominately n-butane is recycled to the dehydrogenation area. The depropanizer overhead and deoiler bottoms are used as fuel.

Alkylation . . . Commercial isobutane together with the concentrated butylene streams are reacted in a conventional sulfuric acid alkylation plant using the effluent refrigeration principle.

The alkylation product is separated in a conventional fractionation train. The propane recovered is used as fuel, isobutane is recycled within the alkylation system, and n-butane is recycled to the dehydrogenation area. The recovered light alkylate is used to blend 115/145 aviation gasoline and the heavy alkylate is marketed as motor-gasoline blending stock.

Keep butadiene loss down . . . The greatest need for process stream analyzers in this plant is in the butadiene and butylene-recovery area. The butadiene loss in this area must be kept at a minimum for economic reasons, making it imperative that at several points in the system close control should be maintained to keep down this loss.

2. INFRARED ANALYZERS

Three Consolidated-Phillips infrared analyzers were installed in the butadiene-recovery area before the plant startup. These infrared analyzers are the negative, nondispersive type. (See Fig. 2 for diagram of optics.) Two equal beams of radiation are taken from a single source, then passed through sensitizing and compensating cells and the sample cells. The remaining energy in each beam is incident on its respective bolometer element. Any difference in the energy of the two beams causes an unbalance in

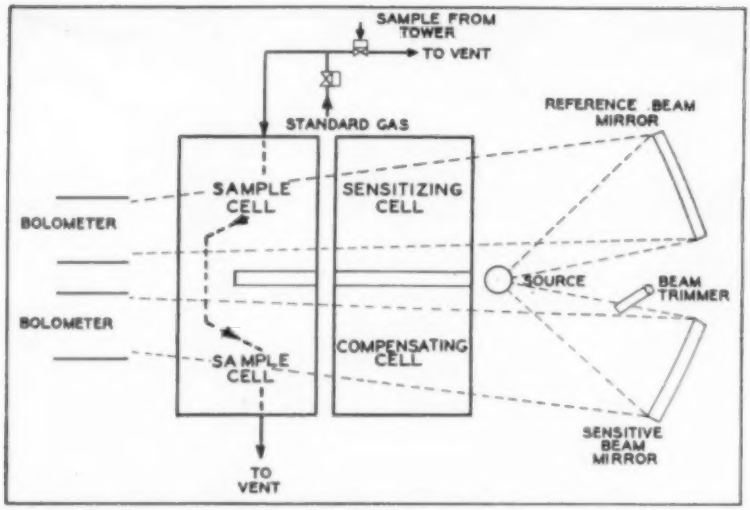
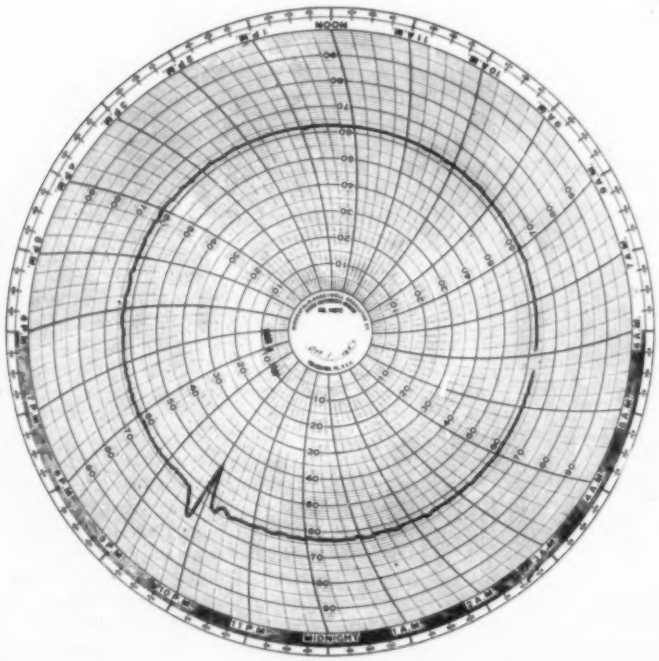


DIAGRAM of optics of Consolidated-Phillips infrared analyzer. Fig. 2.



RECORDER CHART of an infrared recorder controller. Note how the upset at 9:40 p.m. was automatically brought under control. Fig. 3-A.

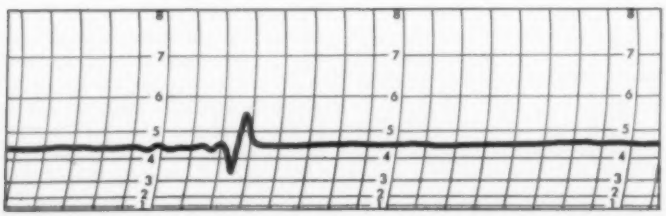


CHART from FRC controlling steam to reboilers of south furfural absorber. Note change in steam flow due to reset action of IRRC to bring upset condition under control. Fig. 3-B.

a Wheatstone-bride circuit. A servo motor drives a potentiometer to rebalance the bridge. The rotation of the potentiometer shaft is calibrated in per cent of the component of interest.

On Furfural Absorber Towers

Two infrared analyzers were installed to take a vapor sample from the twenty-fifth tray (numbered from kettle) of each of the two furfural absorber towers. Each analyzer was sensitized to determine the butene-1 plus isobutylene concentration within a range of 0-40 mole %. Both analyzers have been used as recorder controllers. The unit operator selects a set point on the recorder for the desired concentration level. When the analyzer detects either an increase or decrease in the butene-1 plus isobutylene concentration a pneumatic signal from the recorder resets a flow controller. This flow controller adjusts the steam to the reboilers accordingly.

Charts . . . Fig. 3A shows a recorder chart and Fig. 3B a chart from the steam FRC. These charts show that a change in butene-1-isobutylene concentration, at the sample point, was automatically returned to normal. This was accomplished by the IRRC resetting the FRC on the steam to the reboilers. One analyzer is presently in this service.

Total unsaturates . . . Due to a recent process change, the operation of the north furfural absorber can be accomplished more successfully by knowing the total unsaturates in the overhead product of this column. Therefore, the other analyzer has been resensitized to measure 0-15 mole % total olefins in a furfural absorber overhead stream. In its present service it is not used as a controller.

Sample systems . . . These systems, used on both analyzers, are unusual. A Consolidated-Phillips vaporizer regulator is close-coupled to the sample point to insure a properly vaporized low-pressure sample. Since some furfural is carried over with the sample, steam or water (depending on season) is injected into the sample line immediately after it leaves the vaporizer-regulator. This serves two purposes: first to dissolve the furfural, second to keep the sample line from becoming plugged. At the analyzer the sample flows through a liquid-dropout trap and a water scrubber. This removes the steam, water, and furfural before the sample enters the analyzer. The only problem experienced with this sampling system has been in maintain-

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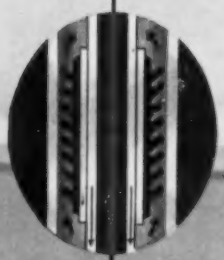

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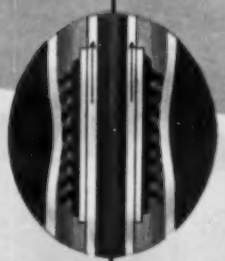
On the down stroke, clearance between fins and pipe allows swab to fall free.



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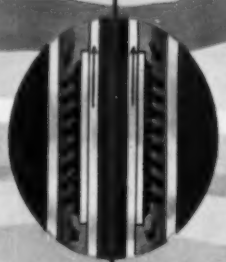
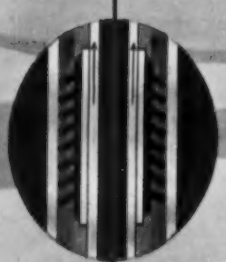


3. RELEASES OVERLOADS

When load is excessive, fins bend down to bypass excess fluid. This safety relief action prevents overloads and broken wire lines.



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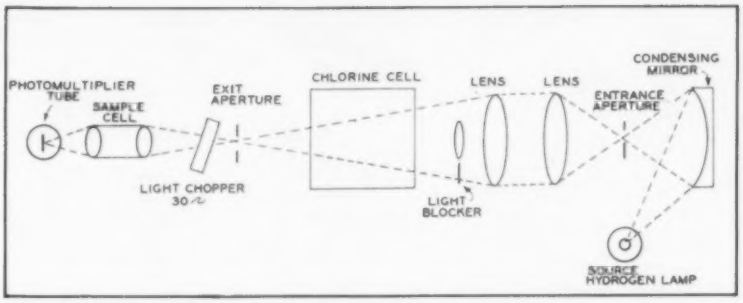


DIAGRAM of optics of Consolidated-Phillips ultraviolet analyzer. Fig. 4.

ing the proper flow rate of the injected steam.

Some of the undesirable impurities found in polymerization-grade butadiene are acetylenes. Assurance that the finished product will have less than the maximum allowable acetylenes is obtained by monitoring the acetylene content several trays below the top of the column.

Butadiene finishing column . . . The third infrared analyzer was installed to take a vapor sample from the seventy-ninth tray (numbered from kettle) of the butadiene purity tower. This analyzer determines the acetylene concentration within a range of 0-3 mole % and may be used as a recorder-controller. A pneumatic signal from the analyzer's recorder can be used to reset a flow controller on the kettle takeoff. Since acetylenes have not been too much of a problem this analyzer has not been placed on control.

3. ULTRAVIOLET ANALYZERS

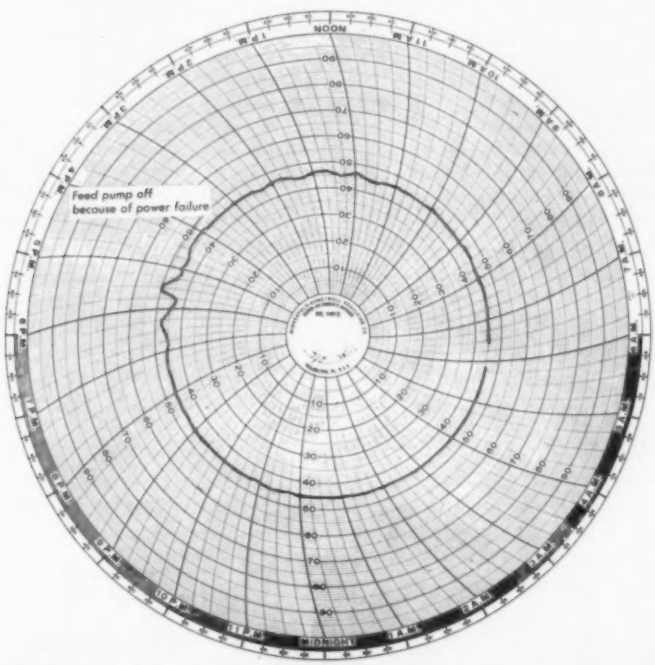
Five Consolidated-Phillips ultraviolet analyzers were installed in the butadiene-recovery area before the plant startup. These analyzers are optically double-beam instruments, although physically there is only one light path as shown in Fig. 4. An optical chopper intercepts the light beam at 30 c.p.s. During one-half cycle the chopper will transmit radiation from 210 mu to 280 mu to the photomultiplier detector. In the other half cycle the chopper transmits radiation from 230 mu to 280 mu. The latter half cycle acts as a reference beam. An increase in the butadiene concentration will cause a decrease in the unbalance between the two half cycles. This change in unbalance is calibrated as per cent butadiene.

Butylene Splitter Columns

All five analyzers measure per cent butadine, but with different concentration ranges. The butylene splitter bottom product is not used to control the splitters because this material contains acetylenes and "heavier than C_4 hydrocarbons," some of which interfere with the analysis of butadiene-1,3 as determined by ultraviolet spectrophotometry. A sample point was selected on these columns which would give an absolute value for butadiene as determined by this method of analysis and at the same time was near enough to the bottom of the column so that a direct ratio exists between the butadiene concentration at the two points.

Ultraviolet recorder-controllers . . . Two analyzers are used on the two butylene splitter columns. One samples the eleventh tray of the north butylene splitter and determines butadiene concentration within a range of 0-3 mole %. The other analyzer samples the nineteenth tray of the south butylene splitter. Its butadiene concentration range is 0-5 mole %. Both analyzers are being successfully used as recorder-controllers. A change in butadiene concentration at the sample point causes a reset of the flow controller on the 70-lb. steam to the reboilers. This reset continues until the butadiene concentration returns to a predetermined level.

Fig. 5 shows a recorder chart from the north splitter. The unit was on auto control. Note, the control maintained when feed pump was off due to power failure.



RECORDER CHART from UVRC analyzer on north splitter eleventh tray. Note control maintained when feed pump was momentarily off due to power failure. Fig. 5.

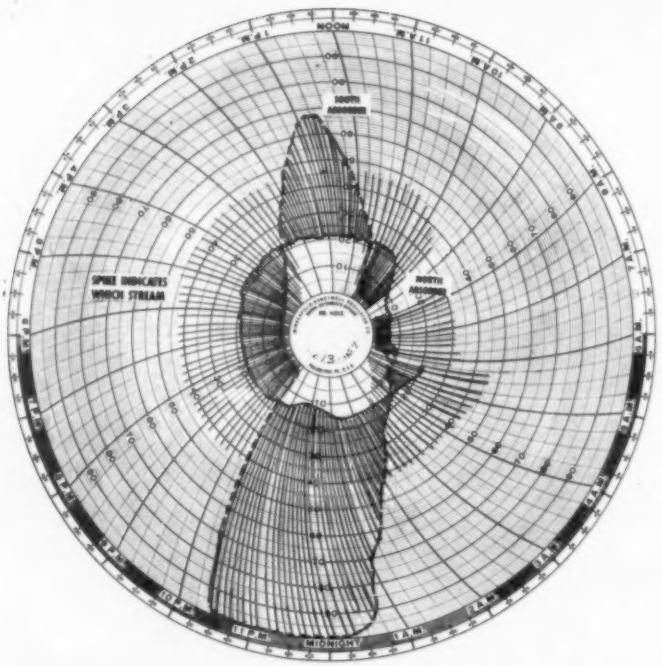
Deoiler and Depropanizer

The overhead vapor lines on both the deoiler and the depropanizer are alternately monitored every 5 minutes. The range of butadiene concentration on this analyzer is 0-10 mole %. Since this analyzer samples more than one process stream, no attempt has been made to use it as a controller.

The deoiler overhead stream is monitored to determine the butadiene loss which eventually is fed to the alkylation unit while the analysis of the depropanizer overhead determines the butadine loss to fuel.

Monitoring Furfural Absorbers

A fourth ultraviolet analyzer was installed to alternate every 5 minutes between the overhead vapor lines of the two furfural absorbers. Since one tower is no longer in its original serv-



RECORDER CHART from dual-stream UVR analyzer. It shows the butadiene in north furfural absorber overhead under normal operating conditions and the south furfural absorber overhead under upset conditions. Fig. 6.

ice, the analyzer monitors the overhead of the other tower continuously. The analyzer makes available to the unit operator the butadiene concentration within a range of 0-3 mole % at any given time. Fig. 6 is a recorder chart from this dual stream ultraviolet analyzer. It shows the north furfural absorber under normal operating conditions and the south furfural absorber under upset conditions. The spikes on the chart enable the operator to determine which stream is being analyzed. It is not used as a controller.

Refering back to Fig. 1 note that butadiene in the south absorber overhead product must be kept at a minimum since it is not only lost but is detrimental in the alkylation process.

Butadiene to Kettle Product

The fifth ultraviolet analyzer samples the third tray of the butadiene purity tower. From this analyzer the amount of butadiene loss in the kettle product can be determined. It can be used on control to reset the flow controller on the kettle takeoff. This analyzer has not been used on control because of materials in the sample that appear to the analyzer as butadiene. The tower is at this time being studied to determine if this may be overcome by relocating the sample point.

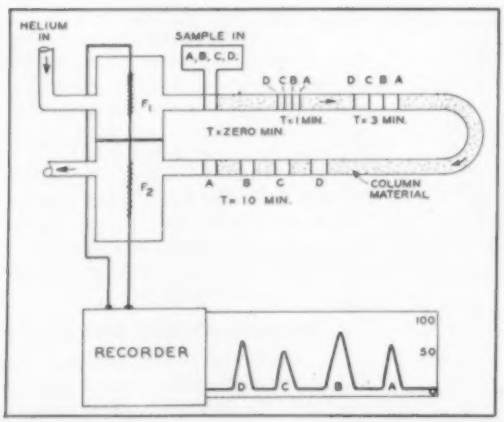
4. GAS CHROMATOGRAPHY

One month after plant startup a Perkin-Elmer Model 178 process-gas-chromatography analyzer was installed in the butadiene-recovery area. Four months later a second unit was installed in the alkylation area. These analyzers operate on much the same principle as the laboratory instruments. The basic operation of a gas-chromatography instrument is shown in Fig. 7.

Gas Chromatography

With a carrier gas flowing through the instrument a sample containing components A, B, C, and D may be injected with a sample valve. As the sample progresses through the column the components begin to separate, depending upon the affinity of that particular column for the different components.

Detector . . . As shown in Fig. 7 the components are well separated when they emerge from the column to pass across one side of the detector. The detector is a simple Wheatstone bridge made from thermal conductivity cells. On side is used as a reference by flowing only the carrier gas across it. When the carrier gas plus the individual components flow across the sensing side of the bridge an unbalance occurs across the bridge. This is due to the difference in the thermal conductivity of the carrier gas, flowing across the reference side, and the carrier gas plus the sample component, flowing across the sensing side of the detector. The unbalance of the bridge is normally measured by



SIMPLE DIAGRAM of a basic gas chromatography unit. Fig. 7.

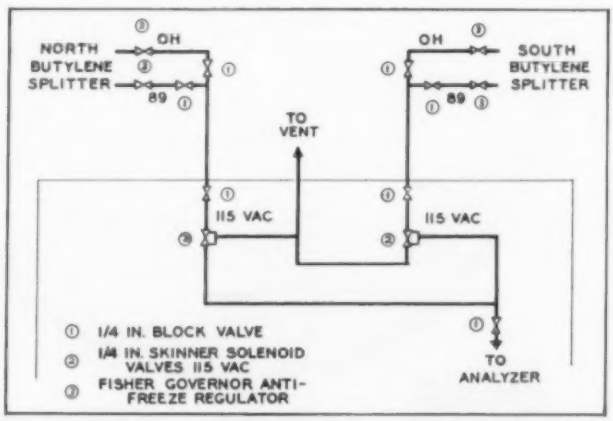


DIAGRAM of sampling system for dual-stream gas chromatography analyzer. Fig. 8.

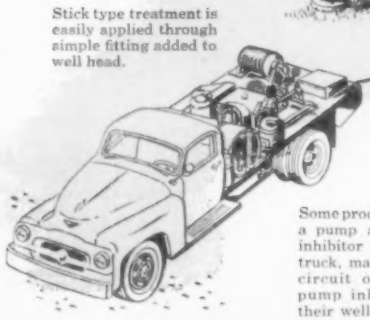
Facts ON Visco® CORROSION PREVENTION

Here are facts on Visco Corrosion Inhibitor costs in a wide variety of producing oil and gas wells—probably some near you . . . or with corrosion problems like yours. At every well, Visco treatment is only a small fraction of the cost of corrosion damage in untreated wells.

WELL TYPE	WELL LOCATION	DAILY PRODUCTION Oil bbls	Water bbls	Gas MCF	Frequency of Visco Treatment	Cost of Visco Treatment per bbl of produced fluid
Pumping	East Texas	40	300	—	3 times a week	.13¢
Pumping	Eastern Kansas	2	492	—	Once a week	.03¢
Flowing	West Texas	20	6.3	—	Twice a week	.22¢
Pumping	Northern Kansas	10	70	—	Once a day	.62¢
Gas Lift	West Texas	20	20	—	Once a day	2.8¢
Pumping	North Texas	—	2000	—	Once a day	.16¢
Pumping	Eastern Kansas	—	250	—	Twice a week	.11¢
Flowing	East Texas	51	155	1	Once a day	.28¢
Flowing	West Texas	420	—	—	Twice a week	.13¢
Gas	East Texas	25	Trace	22.9	Twice a week	4.6¢*
Pumping	West Texas	420	210	—	Every other day	.14¢
Pumping	West Texas	441	441	—	Every other day	.052¢
Gas	Northern La.	—	—	23.4	Once a day	2.42¢*
Pumping	Eastern Kansas	—	250	—	Once a day	.15¢
Pumping	Kansas	100	948	—	Twice a week	.13¢
Gas	Louisiana	9.2	Trace	300	2 Sticks every other day	.66¢*
Pumping	East Texas	46	176	0.92	Once a day	.27¢
Pumping	East Texas	51	155	1.0	Once a day	.28¢
Pumping	East Texas	20	400	—	Three times a week	.12¢
Pumping	Eastern Kansas	2.5	276	—	Once a week	.09¢

*Cost in cents per million cubic feet.

Stick type treatment is easily applied through simple fitting added to well head.



Some producers mount a pump and tank of inhibitor on a small truck, make a regular circuit of leases to pump inhibitor into their wells.

For fast action on a sound, money-saving approach to your downhole corrosion problems, call Houston, JAckson 8-2495, or contact your Visco Field Service Man.

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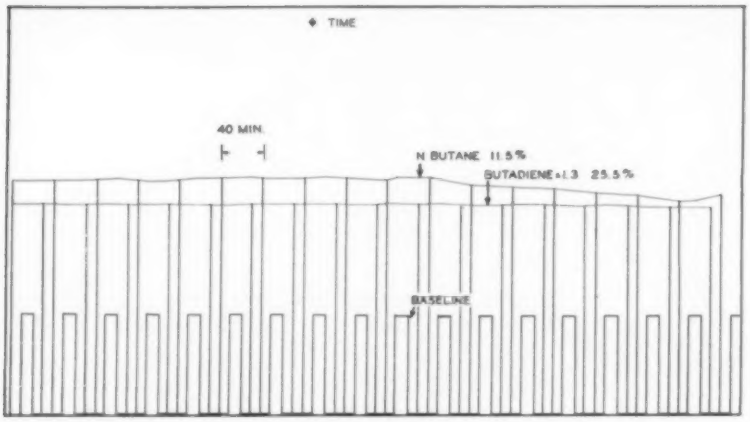

CHART from dual-stream gas chromatography analyzer showing overhead of north butylene splitter. Fig. 9.

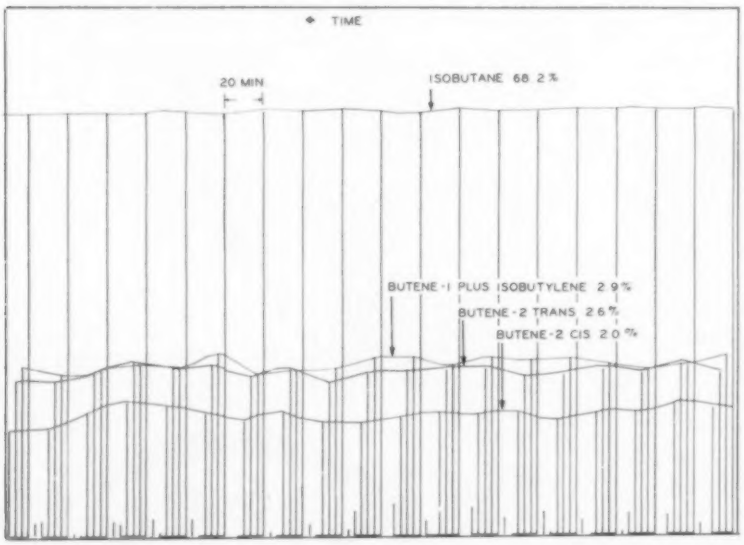

CHART from gas chromatography analyzer on total charge to contactors in alkylation. Fig. 10.

a recorder as shown in Fig. 7. Peaks A, B, C, and D represent the respective components.

Basic elements . . . There are five items that are basic to all gas-chromatography instruments: (1) a source of carrier gas, (2) a method of sample injection, (3) a chromatographic column, (4) a detector, (5) a recorder. (The latter is not a necessity, but is normally used.) Add to these a control unit or programer which will automatically inject the sample on a preset time cycle and present only the analysis of the components of interest and you have a basic plant analyzer.

Refinements . . . Of course, the instrument must be explosionproof and a number of refinements must be made depending on its application. The refinements include such things as: (1) selecting the appropriate recorder range for each component of interest at the proper time, (2) presenting the baseline before each analysis so that the drift of the analyzer may be determined, and (3) controlling the recorder chart drive if the bar-graph form of presentation is to be used.

Programer

The two gas-chromatography analyzers installed at the plant have a programer that operates on a 20-minute cycle. As a cycle begins a measured volume of vapor sample is automatically injected into the column.

Sequence . . . The following sequence occurs as the sample progresses through the column: (1) one minute after sample injection the sample valve returns to the purge position, (2) the baseline is presented across the most sensitive recorder range (attenuator position). This enables the operator to determine the analyzer drift. A device that will automatically correct for any analyzer drift will be installed in the near future, (3) as the first component of interest is eluted from the column the detector output is switched across a recorder range that is set for that particular component, (4) since the bar-graph form of presentation is used the next step is to move the recorder chart about ⅛-in. (See Fig. 10). Steps 3 and 4 are repeated for each component of interest—to a maximum of five—with each component having its own recorder range setting.

Recovery Area

The gas-chromatography analyzer put in service in the recovery area was installed to take a vapor sample from the eighty-ninth tray or overhead of either the north butylene splitter tower or the south butylene splitter tower. The switching from one tower to the other was done manually. This was not satisfactory.

Automatic switching . . . Since both streams were very similar, it was noted that there would be very little difficulty encountered in switching the streams automatically. The actual stream-switching device consisted of a repeat-cycle timer and two three-way solenoid valves. Because both streams were so much alike, a second recorder was installed to insure there would be no mixup in reading the analysis. The cycle timer selected had a cycle twice as long as that of the analyzer programer. This enables the timer to select the proper sample stream and recorder with less chance of trouble due to the synchronization of the timers. A schematic of the sample lines used on the dual stream analyzer are shown in Fig. 8.

Dual-stream analyzer . . . The dual-stream gas-chromatography analyzer is set up to show per cent n-butane 0-20 mole % and butadiene-1,3 0-50 mole %. Although there are eight components in the sample only two are presented on the recorder chart. The time required for the analysis of each sample is 20 minutes, thus, each stream is analyzed every 40 minutes. During the past nine months, analyses on approximately 20,000 samples have been completed with no indication of any change in the column. This analyzer and the dual sampling system have been almost maintenance free.

Fig. 9 is a recorder chart showing n-butane and butadiene 1,3, from overhead of n-butylene splitter.

Alkylation Area

The gas-chromatography analyzer placed in service in the alkylation area was installed to sample the total charge to the contactors. The purpose of the analyzer was to make the isobutane to C_4 olefin ratio available to the operating personnel. The total charge is a liquid stream and the analyzer requires a vapor sample. Therefore, a Consolidated-Phillips vaporizer regulator was installed to vaporize a sample from this stream of liquid C_4 hydrocarbons.

Isobutane and butenes recorded . . . The analyzer was required to show the concentration of isobutane butene-1 plus isobutylene, trans butene-2, and cis butene-2. Isobutane normally ranges about 70 mole % while the total of the olefins normally range below 10 mole %. The recorder range for isobutane was set so that isobutane could be determined by reading the chart division directly. The recorder ranges for all the olefins were set so that the number of recorder divisions divided by 10 would indicate per cent concentration i.e. 20 recorder divisions equal 2 mole %. Fig. 10 is a recorder chart from this stream.

Conclusions

The experience at Texas Butadiene & Chemical Corp. with three different type analyzers seems to point to gas chromatography as one of the easier methods of monitoring a process stream. However, each of the other types of analyzers certainly have their place in the field. The personnel at Texas Butadiene are continously studying the plant process streams for new applications of process stream analyzers of all types.

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3. Phillips, C., "Gas Chromatography," Academic Press Inc., New York, N. Y.

Manpower for maintenance drops

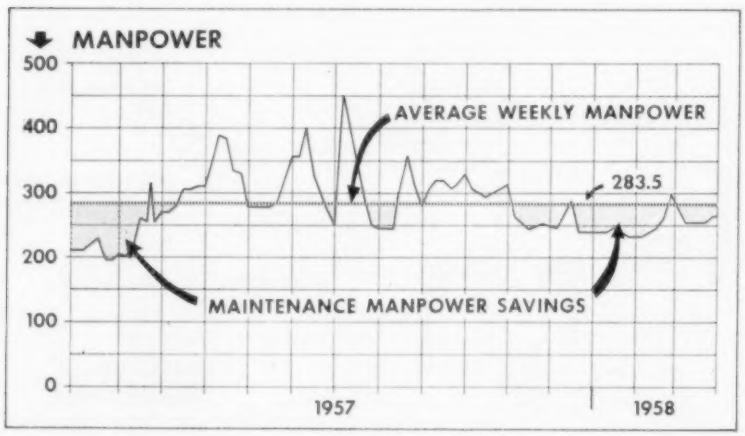
. . . at Tidewater's Delaware City plant

MAINTENANCE manpower requirements at Tidewater Oil Co.'s 130,000 bbl. per day Delaware City, Md., refinery averaged about 250 for the 5 months from November 1957, through March 1958. The recent average compares with an average of 283.5 since the beginning of 1957.

These requirements hit their peak, 450, in mid-1957, according to Alan McCone, assistant to the president, Catalytic Construction Co. The peak came at a time when a major shutdown and revamp program were undertaken. This peak contrasts with a low of less than 200 when the refinery was still under construction.

Catalytic Construction has contracted with Tidewater for the maintenance management of the refinery. Its experience was discussed by McCone in a talk before a recent National Petroleum Association meeting.

After the midyear 1957 peak, the trend in maintenance manpower needs declined steadily through the rest of the year. It has been relatively stable since with the exception of two instances when it neared 300. During this period, the range has been from a low of around 230 to the peak of about 300.



BOOKS

A SURVEY OF SECONDARY RECOVERY AND PRESSURE MAINTENANCE OPERATIONS IN TEXAS TO 1956. Published by Interstate Oil Compact Commission, P. O. Box 3127, Oklahoma City 5. 178 pages. $2.

The data presented in this survey of secondary-recovery and pressure-maintenance projects supplement data presented in the 1954 survey and presents for the first time a report on those projects initiated since January 1, 1954.

Summary data for 194 injection projects initiated since January 1, 1954, and supplemental data on 436 projects reported in the 1954 survey are presented in tabular form. The tabulation does not include all gas injection projects in Texas Railroad Commission districts 7-B and 9, nor does it include cycling projects in gas-condensate reservoirs.

Brief discussions of 34 projects, supplemental reports of 14 major projects discussed in the 1952 and 1954 surveys and a more-detailed discussion of 4 major projects are included.

A list of discussions, plats, performance curves, and other material contained in the 1952 and 1954 surveys appear for reference.

In addition, a current bibliogarphy of literature pertinent to secondary recovery and pressure maintenance in Texas is furnished.

PETROLEUM, PREHISTORIC TO PETROCHEMICALS. By G. A. Purdy. Published by Copp Clark Publishing Co., Vancouver, Toronto, Montreal. 492 pp. Price $12.50.

This book, with its hundreds of graphs and pictures will appeal to the non-technical reader as well as to the petroleum expert; both will read with equal facility and interest. A comprehensive account of the petroleum and petrochemical industries, especially in Canada, this fine reference book tells the story of petroleum from its geological beginning to its present-day products. It tells the story of how oil is found, produced, and transported; how it is processed, and how it is used.

TOWARD THE FACTORY OF THE FUTURE. Published by American Management Association, Inc., 1515 Broadway, New York 36, 96 pp. $2.50 (AMA members: $1.75).

The factory of tomorrow is fast developing out of today's technological advances. Automation and other innovations are suggesting new ways to increase profits, reduce costs, and speed up productivity.

This AMA special report describes how leading companies are currently adapting these innovations to their manufacturing operations. Representatives of National Biscuit Co., Kopper Co., Inc., Dasol Corp. and others, discuss the impact of automation on basic production areas, including maintenance, materials handling, transportation, and manpower utilization.

Note: The Oil and Gas Journal maintains a book department. Write to the READER SERVICE DEPARTMENT, P. O. Box 1260, Tulsa 1, for copies of the book list. Often books reviewed here may be purchased from this source.

PIPELINES

How to calculate

Unsteady-state flow of natural gas in long pipelines

Here's a program developed for computation using the basic IBM 650 computer

BY J. M. NELSON AND J. E. POWERS

WHAT HAPPENS in a long gas-transmission line when there is a sudden decrease in outlet pressure?

What is the storage potential of the line, rate of depletion of the gas from the pipeline, and decrease in inlet pressure?

● To answer such questions a program has been developed at University of Oklahoma for machine computation of unsteady-state behavior of natural gas in relatively long sections of pipeline. Such a computer program may be called upon to aid in planning a compressor station supplying gas to a distribution point subjected to a variable demand.

● An example calculation is given in which unsteady-state behavior of a 30-in. diameter pipeline 105 miles long is determined when subjected to a sudden decrease in outlet pressure.

A complete engineering evaluation of flow of natural gas or other compressible fluid in long pipelines is rarely made at present. This is due to lack of theoretical knowledge concerning transient or unsteady flow of compressible fluids resulting from demand changes, compressor fluctuations, etc.

Introduction of electronic computers now makes it possible to obtain solutions to many complex physical problems. Accordingly, this article covers:

1. Derivation (briefly) of equations which describe the physical behavior of the gas in the pipeline for any change in operating conditions at the ends of the pipe. Such equations are suitable for machine computation as, in this case, the IBM 650.

2. Illustration of use of these equations in a computer program to determine effect of changes in terminal conditions.

1. Developing Basic Equations

To take full advantage of the capabilities of the computer, equations in numerical form which describe the behavior of the gas in the pipeline were developed directly for numerical computation. In other words the differential equations describing the physical behavior of the gas were not solved by numerical methods; but instead, equations were developed for numerical solution by applying fundamental principles to relatively large portions of the gas. Since this approach is somewhat novel and would appear to have several advantages, a partial derivation is presented below. Complete details have been presented elsewhere.[5]

Simplifying Assumptions

It is believed that the assumptions made in the following analysis of gas flow are reasonable and therefore the resulting computer program can be used to solve a great many problems in gas transmission associated with transient phenomena.

The analysis applies only to pipelines that are horizontal and of constant cross-sectional area. No chemical reaction or phase changes occur within the pipe and no gas is added or removed between the inlet and the outlet.

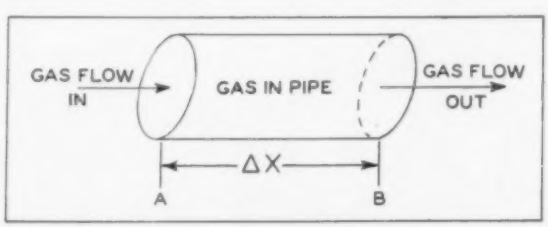
In order to simplify the equations it is assumed that the velocity, density, etc., are not dependent on the radial and angular positions in the pipe. All of the terms in the equations are therefore functions only of time and position along the pipe. This introduces some error in the kinetic-energy terms which are generally small compared to the other terms in the equation. It is possible to reduce this error by the use of a correction factor.[3]

In the course of the complete derivation it is further assumed that the temperature of the gas remains constant, the friction factor is constant, and the nonideality of the gas phase can be accounted for by the Z factor which itself is a simple straight-line function of the pressure. The assumptions described in this paragraph were made to permit the calculations to be performed in a reasonable time on the basic IBM 650 computer which was available. Relations as complicated as the Moody friction-factor relation[4] and the Benedict, Webb, and Rubin equation of state[1] could readily be incorporated if the application justified the expense of additional computing time.

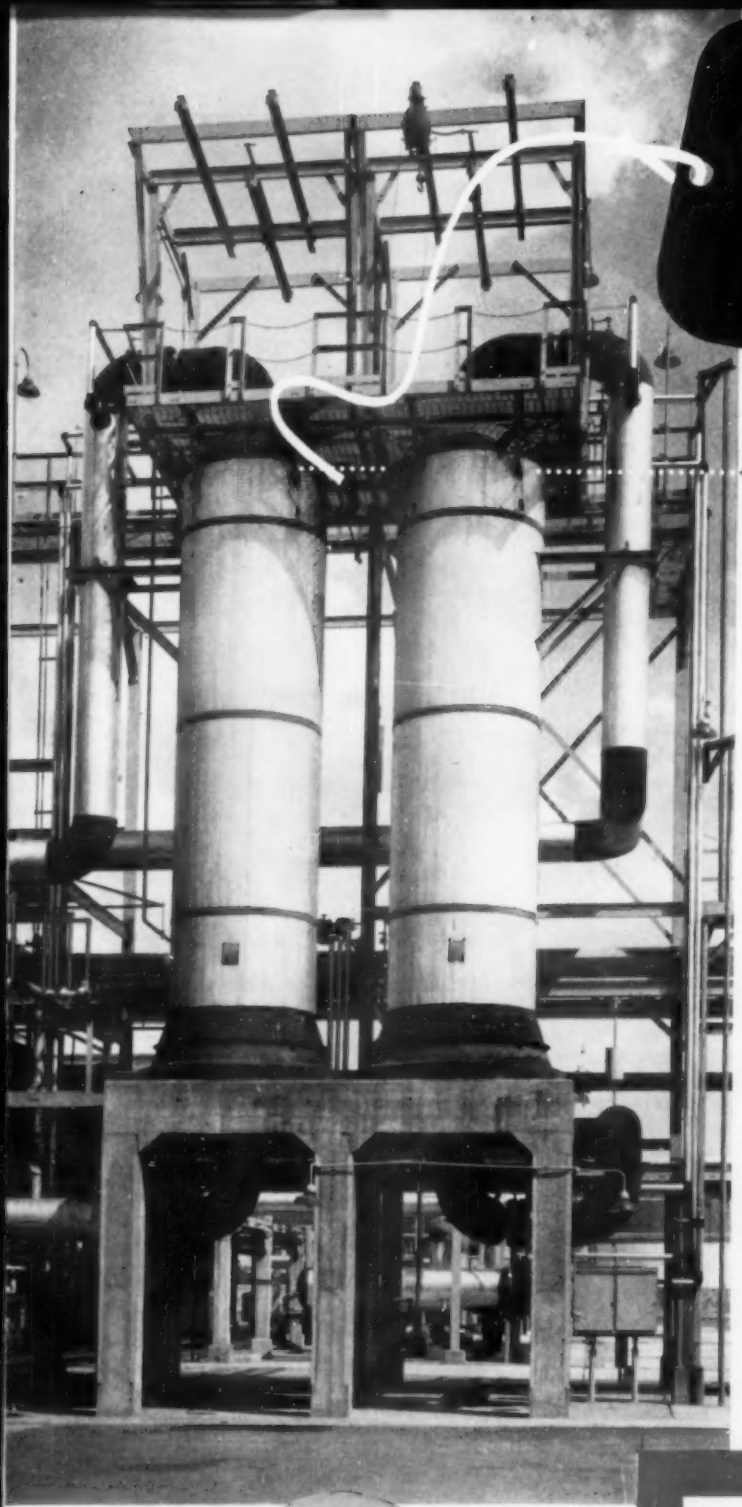
Derivation of equations . . . The two fundamental principles used in analyzing the isothermal behavior of gas in a pipeline are the conservation of mass and the conservation of momentum. The method of derivation will be illustrated by applying the principle of conservation of mass to the gas in a short section of pipe. The application of the principle of conservation of momentum follows the same pattern and so only the resulting equations will be presented.

Mass balance . . . The principle of

J. M. Nelson is with E. I. Du Pont de Nemours & Co. at Parkersburg, W. Va. Dr. J. E. Powers is professor in School of Chemical Engineering, University of Oklahoma, Norman.



SECTION of pipeline containing a compressible fluid. Fig. 1.



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SPECIFICATIONS:

CONSTRUCTION: A301 Grade B Firebox
SIZE: 5-ft. 6-in. diameter by 30-ft. high
DESIGN PRESSURE: 700 pounds per square inch
DESIGN METAL TEMP: 985° F
PLATE THICKNESS: 3 1/8-in. shell
CATALYST USED: Metallic platinum, finely dispersed
CONTROL: Temp. & Pressure: Very CRITICAL
PRODUCT IN: Low Octane gasoline
PRODUCT OUT: High Octane gasoline

FABRICATING CONTROLS USED

✓ STRESS RELIEVED ✓ RADIOGRAPHED
✓ API-ASME CODE

DESIGNER: Procon, Incorporated
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conservation of mass is often written in the form

Input — Output = Accumulation (1)

In applying the principle to a section of pipe of finite length, ΔX, (see Fig. 1) over a finite increment of time, $\Delta\Theta$, the input (or mass of gas that passes plane A during the time interval $\Delta\Theta$) is calculated from the relation

$$\text{Input} = (\pi D^2/4)\,(\rho V)_{aA}\Delta\Theta \qquad (2)$$

where D is the pipe diameter,
ρ = the gas density,
V = the gas velocity and the subscripts "a" and "A" have special meaning.

A consistent subscript notation is used to identify variables that change with time and position. The second subscript always denotes position in the pipe and in Equation 2 the "A" subscript identifies material passing through plane "A." The first subscript refers to time. The subscript "a" indicates that proper average values with respect to time are required to calculate the exact amount of mass flow over the time interval $\Delta\Theta$, since for unsteady-state flow conditions the product ρV at plane A will vary with time.

Similar consideration of the output and accumulation terms yields Equation 3.

$$[(\rho V)_{aA} - (\rho V)_{aB}]\,\Delta\Theta = [\rho_{2a} - \rho_{1a}]\Delta X \qquad (3)$$

where ρ_{2a} is the density of gas at the end of the time interval (2) and averaged over the length from A to B. Similarly ρ_{1a} identifies the length average density at the beginning of the time interval.[1]

Although Equation 3 is exact by definition of "proper" average values, denoted by the "a" subscript, it is necessary to approximate the exact values of the averages in order to make practical calculations. For ease in calculation arithmetic averages are used. For example

$$\rho_{1a} \cong (\rho_{1A} + \rho_{1B})/2 \qquad (4)$$

and

$$(\rho V)_{aA} \cong (\rho V)_{1A} + (\rho V)_{2A}/2 \qquad (5)$$

Similar relations hold for ρ_{2a} and $(\rho V)_{aB}$.

Substitution of the arithmetic average approximations and algebraic manipulation yields Equations 6, 7, and 8.

$$(\rho V)_{2B} = K - \rho_{2B}(\Delta X/\Delta\Theta) \qquad (6)$$

where

$$K = H + (\rho V)_{2a} - \rho_{2A}(\Delta X/\Delta\Theta) \qquad (7)$$

and

$$H = (\rho V)_{1A} - (\rho V)_{1B} + [\rho_{1A} + \rho_{1B}]\,(\Delta X/\Delta\Theta) \qquad (8)$$

The particular form of Equations 6-8 were adopted for ease of machine computation.

Momentum balance . . . In the application of the principle of conservation of momentum it is necessary to estimate variables which are averaged with respect to both time and distance.

One such variable is $(\rho V^2)_{aa}$ which is used to estimate the loss due to friction at the walls by application of the friction-factor equation.

Following the procedure illustrated by Equations 4 and 5 the term $(\rho V^2)_{aa}$ might best be estimated by

$$(\rho V^2)_{aa} \cong (\rho V^2)_{1A} + (\rho V^2)_{1B} + (\rho V^2)_{2A} + (\rho V^2)_{aB}/4 \qquad (9)$$

In order to simplify the computation the following relation was used instead of Equation 9.

$$(\rho V^2)_{aa} \cong (\rho V^2)_{1B} + (\rho V^2)_{2A}/2 \qquad (10)$$

Finding the correct average for a physical property over finite increments of both length and time can be compared to finding the average elevation of a section of land knowing only the elevation at the corners. If the land were flat, the arithmetic average elevation of opposite corners gives the correct average of all four corners.

Whereas if the land were not flat the average of all four corners may or may not be closer to the true value than the average of the two opposite corners. In most cases, the differences between the two-point average and the four-point average is small compared to the difference between the two-point values.

The equations resulting from the momentum balance are

$$(\rho Z)_{2B} = \frac{M}{RTg_c}\left\{G + K\frac{\Delta X}{\Delta\Theta} + \left[G + K\frac{\Delta X}{\Delta\Theta}\right)^2 - \frac{RTg_cK^2}{M}Z_{2B}\right]^{1/2}\} \qquad (11)$$

where

$$G = J + \frac{(\rho Z)_{2A}RTg_c}{M} + (\rho V^2)_{2A} - (\rho V)_{2A}\frac{\Delta X}{\Delta\Theta} - (f\rho V^2)_{2A}\frac{\Delta X}{2D} \qquad (12)$$

and

$$J = \frac{RTg_c}{M}[(\rho Z)_{1A} - (\rho Z)_{1B}] + (\rho V^2)_{1A} - (\rho V^2)_{1B} + [(\rho V)_{1A} + (\rho V_{1B}]\frac{\Delta X}{\Delta\Theta} - (f\rho V^2)_{1B}\frac{\Delta X}{2D} \qquad (13)$$

Notation

C	Slope of compressibility isotherm as defined by Equation 18
D	Pipe diameter
f	Moody friction factor
g_c	Gravitational conversion factor
G	Arbitrary grouping of variables as defined by Equation 12
H	Arbitrary grouping of variables as defined by Equation 8
J	Arbitrary grouping of variables as defined by Equation 13
K	Arbitrary grouping of variables as defined by Equation 7
k	Slope of isotherm on Z chart.
M	Molecular weight
P	Pressure
P_c	Critical pressure
R	The gas constant
T	Absolute temperature
V	Velocity
Z	Compressibility factor
ΔX	Increment of length
$\Delta\Theta$	Increment of time
ρ	Density
Θ	Time

Subscript Notation

aa	Average with respect to both time and position.
aA	Average with respect to first position "A".
aB	Average with respect to time at position"B".
1a	Time 1 average with respect to position.
1A	Time 1 position "A".
1B	Time 1 position "B".
2a	Time 2 average with respect to position.
2A	Time 2 position "A".
2B	Time 2 position "B".

where,

Z = gas compressibility factor
M = molecular weight of gas
R = gas constant
T = absolute temperature
g_c = gravitational conversion factor
D = pipe diameter
f = friction factor defined by Equation 14

$$f = (2g_c D\, lw/V^2 \Delta X)$$

lw = lost work per mass of fluid flowing

Auxiliary equations . . . In solving Equations 6-8 and 11-13 it was assumed that the temperature and friction factor were constant and that the compressibility factor is a linear function of reduced pressure at constant temperature:

$$Z = 1 - k\,(P/P_c) \qquad (15)$$

where

k = slope of constant temperature line on "Z" chart

P_c = critical pressure of gas

Combining Equation 15 with the equation of state

$$\rho = (Z\rho RT/M) \qquad (16)$$

yields Equation 17

$$Z = 1 - C\rho Z \qquad (17)$$

where

$$C = (kRT/MP_c) \qquad (18)$$

The technique used in the computation is to calculate the conditions at time "2" position "B," from previously determined conditions at time "2" position "A" and time "1" positions "A" and "B." The form of equations is that found to be most useful in machine computation. In actual calculation Equations 11 and 17 are solved by iteration for ρ_{2B} and Z_{2B}. Equation 6 was then solved for V_{2B} and the calculation repeated for the next increment.

Comparable differential equations . . . Equations 6 and 11 are suitable for machine computation but it is very difficult to obtain any "physical feel" for the situation by a casual inspection of these equations. The equivalent differential equations, obtained by the same fundamental method of analysis, are presented below for comparison:

$$g_c(\partial\rho/\partial X) + \partial(\rho V^2)/(\partial X) + \partial(\rho V)/(\partial\Theta) + f\rho V^2/2D\,V/[V] = 0 \qquad (19)$$

$$\partial(\rho V)/\partial X = -\partial\rho/\partial\Theta \qquad (20)$$

where
[V] is the absolute value of velocity. Similar equations have appeared in the literature.[6]

2. Using the Equations-Examples

Consider a compressor station supplying a distribution point, subject to variable demand, through a rather long pipeline. Suppose that the demand at the outlet rises sharply. In order to meet this increased demand the pressure at the outlet of the pipe will drop sharply (no storage of gas for surge purposes other than that in the pipeline is assumed to be available).

The behavior of the gas in the pipeline, i.e. pressure, flow rate, and total amount stored in the pipeline will be influenced by the magnitude of the demand change and the rapidity with which such a change occurs. It will take an appreciable time before a significant change in pressure can be detected at the compressor station and then the gas behavior will be influenced by the nature of the control on the compressor.

The compressor might be controlled to maintain a constant compressor outlet pressure or it might be operated at constant drive horsepower or the inlet mass flow might be maintained at a constant rate by proper compressor control.

The preceding partial listing by no means exhausts the possible combinations. But two facts should be noted:

1. Two and only two variables at the ends can be changed independently. (In mathematical terms, two and only two boundary conditions are required for the complete solution.)

2. Whereas the demand change occurs at the pipe outlet the control usually operates at the inlet or compressor end of the pipe. This fact complicates the numerical solution of the problem.

There are a large number of combinations possible in the consideration of causes for disturbances in pipeline operation and the resulting control action. In the process of this particular investigation only one such combination was considered but this in essence demonstrated the utility of the program.

Example calculation . . . A pipeline 30 in. in diameter and 105 miles long is delivering methane at a rate of 275 M.s.c.f.m. at an outlet pressure of 315 psia. The outlet pressure is suddenly dropped to a new constant value as the result of a increase in demand. The control at the compressor end is designed to maintain a constant flow rate to the pipeline.

Calculations of both the unsteady-state and steady-state behavior of the gas in the pipeline were made for several values of outlet pressure. In these computations the Moody friction factor[5] is set constant at 0.011 and the temperature is assumed to be constant at 520° R. Results of a typical calculation are shown in Table 1. Complete details have been presented elsewhere[5]. Several applications of these results are presented below.

Pipeline storage potential . . . There are approximately 90 M.M.s.c.f. in the 105-mile pipeline described above at a delivery rate of 275 M.M.s.c.f. and an outlet pressure of 315 psia. In order to determine if the gas in the pipeline can be utilized to damper daily demand surges it is necessary to estimate:

TABLE 1—SUMMARY OF COMPUTATION

Initial outlet pressure equals 315 psia.
Outlet pressure equals 167 psia.
Time equals 20 minutes

Velocity f.p.s.	Density lb./ft.^{3}	Compressibility factor Z	Mass flow lb./ft.^{2}/sec.	Pressure psia.	Position in pipe	
21.2	2.01	.917	42.8	643.5	21	Inlet
21.6	1.97	.918	42.8	632.0	20	
22.1	1.93	.920	42.8	620.2	19	
22.6	1.89	.921	42.8	608.2	18	
23.1	1.85	.923	42.8	595.9	17	
23.6	1.80	.925	42.8	583.3	16	
24.2	1.76	.926	42.8	570.4	15	
24.8	1.72	.928	42.8	557.2	14	
25.5	1.67	.930	42.9	543.6	13	
26.3	1.63	.932	42.9	529.6	12	
27.1	1.58	.933	43.0	515.2	11	
28.0	1.53	.935	43.1	500.2	10	
29.1	1.48	.937	43.2	484.6	9	
30.3	1.43	.939	43.4	468.4	8	
31.8	1.37	.942	43.7	451.2	7	
33.5	1.31	.944	44.1	432.9	6	
35.8	1.25	.946	44.8	413.1	5	
38.8	1.18	.949	45.9	391.1	4	
43.2	1.10	.953	47.6	365.7	3	
50.4	1.00	.957	50.5	334.2	2	
64.5	0.86	.962	55.7	289.5	1	
40.9	0.48	.978	69.0	166.9	..	Outlet

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AMOUNT OF GAS made available by decreasing the outlet pressure from 315 psia., in a 30-in.-diameter pipeline 105 miles long. Fig. 2.

1. How much of the gas in the pipeline is made available when the outlet pressure is dropped and
2. The rate at which this gas is made available.

The first question is answered by calculating the difference in the amount of gas in the pipeline at steady-state conditions at equal flow rates but at different outlet pressures. Such estimations can be made by any of several techniques. Such estimates resulted naturally from the computations made in the course of this study. The results are presented in Fig. 2 where the amount of gas that can be removed from the pipeline by decreasing the outlet pressure below 315 psia. (labeled "Storage Potential") is plotted as a function of the outlet pressure.

If the outlet pressure is halved, i.e. decreased from 315 psia. to 160 psia., only 15 M.M.s.c.f. is made available out of the 90 M.M.s.c.f. originally in the pipeline.

The rate at which the gas is made available for distribution at the outlet of the pipeline was estimated by an analysis of the unsteady-state behavior of the gas in the pipeline. The results are presented in Fig. 3. The total depletion from the pipe is plotted as a function of the time. The calculations are presented for the case in which the outlet pressure is decreased suddenly from 315 psia. to 167 psia. After 2 hours, little more than half of the storage potential (See Fig. 2) has been removed.

The rate at which excess gas is made available at the pipe outlet is the slope of the curve of Fig. 3. Thus it can be determined from Fig. 3 that immediately after the pressure is decreased from 315 psia. to 167 psia., the gas rate at the outlet is increased from 275 to 370 M.s.c.f.m. and after 1 hour's operation at the reduced outlet pressure the gas is being supplied at the outlet at a rate of 330 M.s.c.f.m. even though the inlets rate has been maintained at 275 M.s.c.f.m. for the entire period.

Inlet-pressure decrease . . . An investigation of the control characteristics of long pipelines in general will require a knowledge of the rate at which the pressure decreases at the pipe inlet when the outlet pressure is suddenly changed. Fig. 4 presents the results of a calculation of this type for a decrease in outlet pressure from 315 psia. to 167 psia.

The dashed line on Fig. 4 represents the inlet pressure after steady-state conditions are attained at the reduced outlet pressure.

Several features of Fig. 4 are noteworthy. Essentially no change in inlet pressure occurs for almost 1 hour. The change in 100 minutes is less than 20% of the total change that will occur. Control procedures are complicated by such long delay times.

3. Remarks on Machine Program

The program was developed for computation using the basic IBM 650 computer. Minor revisions were incorporated in the program after University of Oklahoma received an IBM 650 computer with floating point and indexing accumulators.

The program requires about 1 minute to develop a steady-state distribution and each succeeding calculation at successive time intervals requires from 10 to 20 minutes. This long calculation period is required because conditions are specified at the two ends of the pipe and an elaborate testing procedure is used to insure that the two boundary conditions are satisfied.

The program is designed to solve problems with a variety of boundary conditions but minor modifications would be required before it could be applied to other problems.

Acknowledgements

The authors express their thanks to John Stevens, of Sohio Oil Co., at Oklahoma City; John Hamblin, of Oklahoma State University, at Stillwater; Howard Johnnson, of Halliburton Oil Well Cementing Co., at Duncan, and the University of Oklahoma computing laboratory, Norman, for making computer time available. Author Nelson thanks W. A. Schlueter for his generous support through a fellowship, which made this work possible. The advice and assistance of Dr. R. L. Huntington and Dr. O. K. Crosser, of University of Oklahoma, are appreciated.

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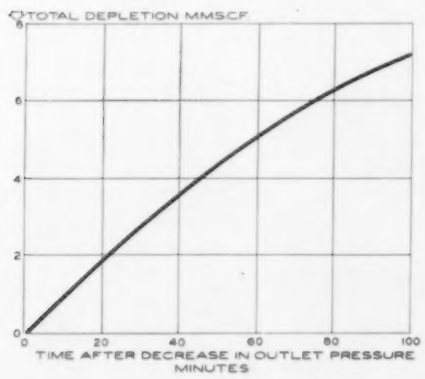
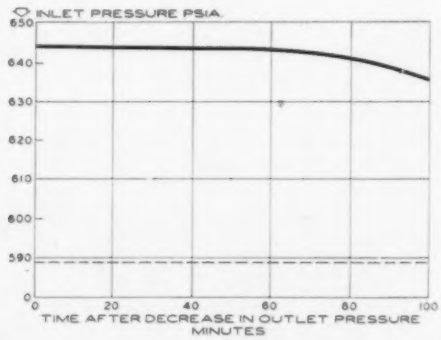
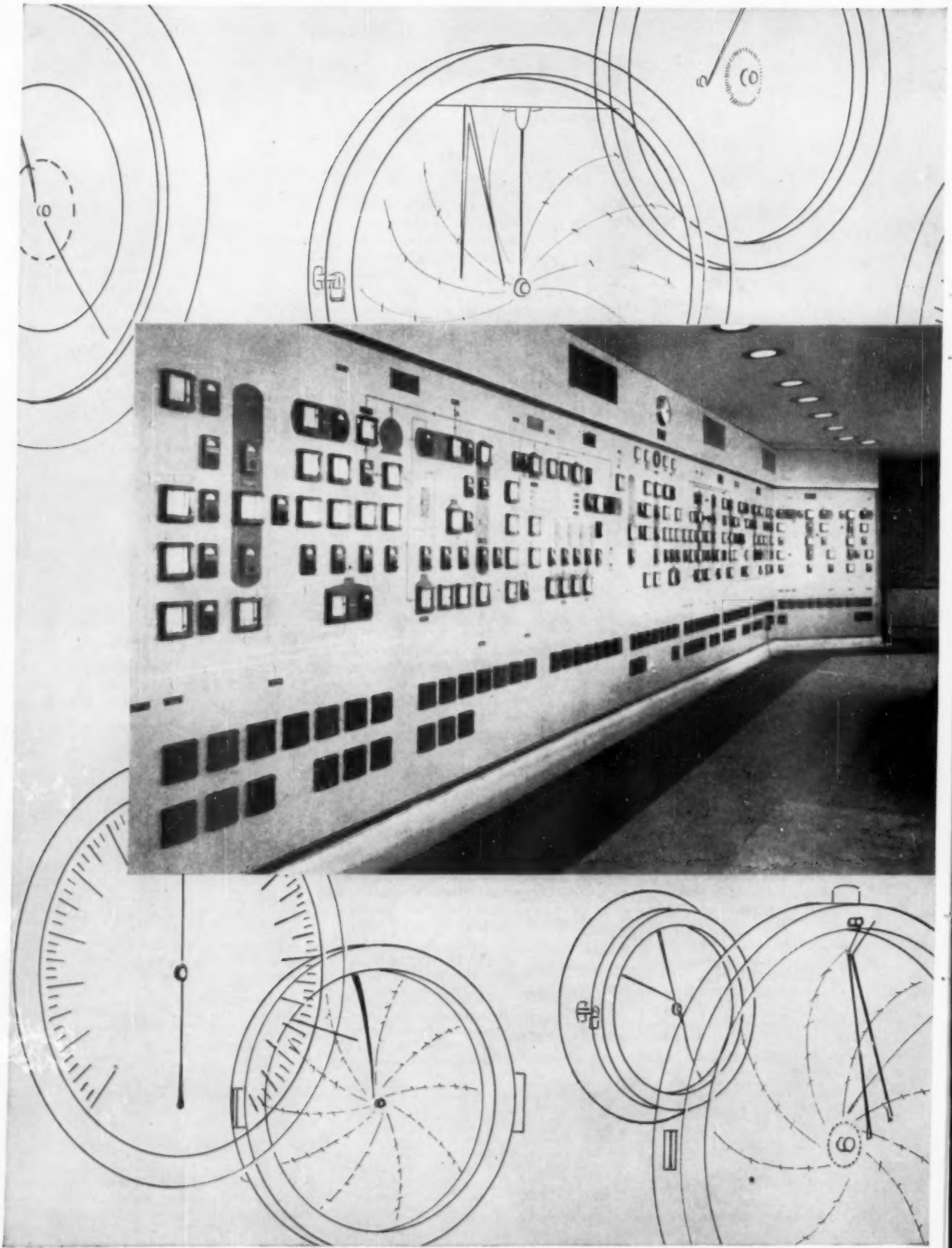


GAS DEPLETION from a 30-in.-diameter, 105-mile pipeline as a function of time for a decrease in outlet pressure from 315 to 167 psia. Fig. 3.

INLET PRESSURE at constant inlet flow rate as a function of time for a decrease in outlet pressure from 315 to 167 psia. Fig. 4.





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ELEMENTS OF FIELD PROCESSING—53

Calculation of compressor horsepower

. . . using ideal gas equations and enthalpy charts

BY DR. JOHN M. CAMPBELL, University of Oklahoma

HORSEPOWER requirements for gas compression may be calculated theoretically by outlining a process that may be described using established thermodynamic relationships. As a practical matter this involves the assumption of an isothermal process ($\Delta t=0$) or an adiabatic process ($q=0$). Most actual compressions are usually called "polytropic"—somewhere between isothermal and adiabatic. Such polytropic process is very close to being adiabatic. Consequently the same basic equations are used to describe the process regardless of which word is used.

The simplest theoretical equations are developed on the assumption that the compression is adiabatic and reversible, the gas being an ideal one. They further assume that the ratio $Cp/Cv = k$ is a constant and independent of changes in pressure and temperature. Incorporating these assumptions into the basic thermodynamic equations yields an equation which may be conveniently written as

$$\text{Theor. hp.} = 44.54 \times [(P_2/P_1)^{(k-1)/k} - 1] \times [k/(k-1)], \text{ M.M.c.f.d.} \quad (1)$$

where:

Cp = specific heat at constant pressure

Cv = specific heat at constant volume

P_2 = compressor cylinder discharge pressure, psia.

P_1 = compressor cylinder suction pressure, psia.

M.M.c.f.d. = million standard cubic feet of gas per day measured at 14.65 psia. at 60° F.

Equation 1 yields results that are limited by the assumptions introduced. The constant k may be found from Fig. 1 which shows it as a function of gas specific gravity. This correlation is not exact but is suitable for routine compressor calculations.[1]

The theoretical horsepower found in Equation 1 is that amount of work that must be performed on the gas. To find engine horsepower this value must therefore be divided by the overall mechanical efficiency of the compression unit. Values of this efficiency, suitable for setting up specifications, are shown in Fig. 2.[2] The compression ratio per stage (P_2/P_1) is the main factor although efficiency certainly depends somewhat on the piston speed and valve design.

The compression ratio per stage R seldom exceeds 6:1 for the efficiency lowers, the volumetric efficiency becomes less, and mechanical stress limitations become more pronounced as R increases. In actual practice R seldom exceeds 4:1 when boosting gas from low pressure for processing or sale. When the total pressure is greater than this, several stages of compression are used.

It may be shown that the total horsepower is a minimum when the ratio in each stage is the same. This may be expressed in equation form as

$$R = (P_D/P_1)^{1/n} \quad (2)$$

where:

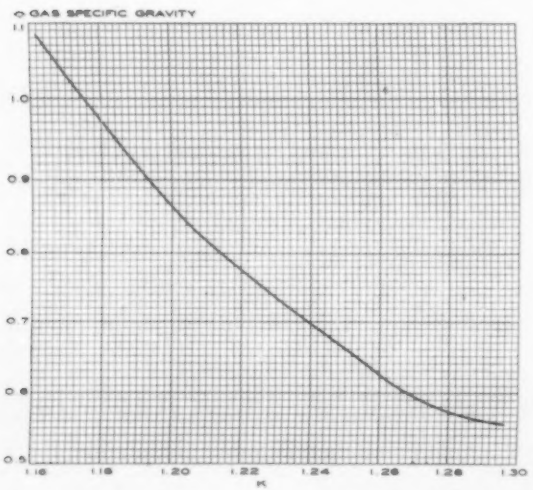
P_D = final discharge pressure, psia.

P_1 = suction pressure, psia.

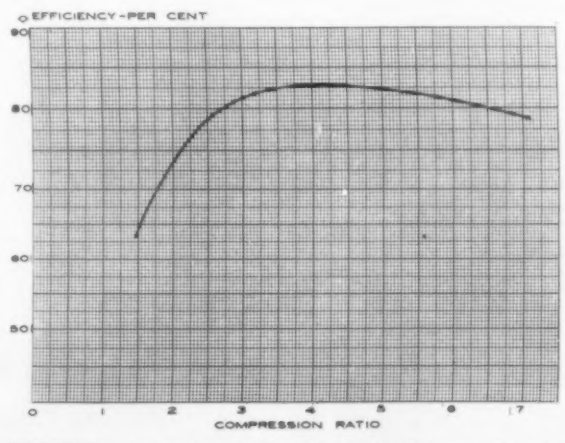
n = number of stages required

Where several stages of compression are used it is necessary to have an interstage cooler and scrubber to cool the gas from the first stage and then collect any liquids formed on cooling. This interstage pressure drop seldom exceeds 5 psi. In order to account for this drop the R found in Equation 2 is usually corrected. One common method is to assign half of the pressure drop to each stage.

Example . . . Determine the engine



CONSTANT "k" as a function of gas specific gravity. Fig. 1.



COMBINED compression and mechanical efficiency of reciprocating compressors. Fig. 2.

horsepower needed to compress 2 M.M.c.f.d. of a 0.67-sp. gr. natural gas from 20 psig. to 600 psig.

$$R = \frac{600 + 14.7}{20 + 14.7} = \mathbf{17.7}$$

This is too high a ratio for single stage, therefore try two-stage.

$$R = (615/34.7)^{1/2} = \mathbf{4.21}$$

Two-stage gives a satisfactory ratio, if the interstage pressure drop is 5 psi. The discharge pressure in the first stage equals (4.21 (34.7) + 2.5 = **148.5 psia.** The suction pressure to the second stage would be 5 psi. less or 143.5 psia. From Fig. 1, **k = 1.25.** Efficiencies from Fig. 2 are

First stage, $R = 148.5/34.7 = \mathbf{4.28}$

$$\text{Eff.} = \mathbf{0.825}$$

Second stage, $R = 615/143.5 = \mathbf{4.29}$

$$\text{Eff.} = \mathbf{0.825}$$

Therefore, from Equation 1, the brake horsepower for each engine per stage

$$= (1/0.825) \times 44.54 \times 2$$

$$\times (4.28^{0.25/1.25} - 1)\ (1.25/0.25)$$

$$= \mathbf{183\ b.hp.}$$

The total horsepower requirements are thus 366 hp. for both stages.

Enthalpy Charts

The theoretical horsepower required for an adiabatic reversible compression ($q = 0$) may also be found from enthalpy-entropy charts. For such an assumed compression path $\Delta H = -w$.

Inasmuch as the thermodynamic term "entropy" may be defined as

$$ds = dq_r/T$$

$ds = 0$ for such a process, where dq_r equals the change in heat energy for a reversible process. An adiabatic reversible process therefore occurs at constant entropy (isentropic process).

Fig. 3 shows the general character of lines encountered in an enthalpy-entropy chart. Such a chart usually consists of enthalpy on the ordinate versus entropy on the abscissa. Within this chart are constructed lines of constant temperature and constant pressure.

Superimposed on Fig. 3, in dashed lines, is a two-stage compression process. Lines A-B and C-D represent the two theoretical compression steps and line B-C the interstage cooling process. Line B-C is not quite parallel to the lines of constant pressure because of the interstage pressure drop.

The total horsepower may be found from the equation

$$\text{b.hp./M.M.c.f.d.} = \frac{(\Delta H)\ (2{,}638)}{(\text{Eff.})\ (2{,}545)\ (24)}$$

$$= \mathbf{0.043\ (\Delta H/Eff.)} \qquad (3)$$

where:

ΔH = the total enthalpy change for the compression step—B.t.u. per lb.-mole

Eff. = over-all efficiency shown in Fig. 2

If the enthalpy change is measured in B.t.u. per lb. the numerator of Equation 3 must be multiplied by the molecular weight of the gas. The number 2545 is a conversion factor from B.t.u. to hp.-hr. and 2638 is the number of moles of gas per M.M.c.f.

The ΔH for use in Equation 3 is found from steps A-B and C-D in Fig. 3. The engine horsepower calculated by this method will usually check very well with that found by theoretical equations.

Interstage cooling . . . The cooling step B-C is normally accomplished using a fan-driven air cooler. For this reason point C is usually at a slightly higher temperature than point A.

Air cooling is used because such units are compact, relatively inexpensive, require little maintenance and no outside utilities. The fan may be driven by the compressor engine. The gas cooler may furthermore be incorporated into the same unit necessary for lube oil and jacket water cooling.

It is usually economically feasible to cool the gas to within 20°-30° F. of the ambient air temperature. To obtain further cooling requires a larger amount of cooling surface and more fan horsepower, which increases the cost tremendously. This is seldom justified.

The interstage cooling load in B.t.u. per hour may be found by:

1. Using an enthalpy-entropy chart of the type shown in Fig. 3.

2. Determining temperature Band C and using a specific heat correlation (see Part 49, OGJ, March 31, 1958).

Convenient enthalpy-entropy charts of the type shown in Fig. 3 may be found in the literature.[3] These are for natural gas only and may not be used if any gas is liquefied during cooling.

When using Method 2, temperature C is usually taken as 20° F. above the air temperature that will not be exceeded over 5% of the time. Temperature B may be found from an enthalpy chart or by equation. For an adiabatic reversible compression

$$T_2/T_1 = (P_2/P_1)^{(k-1)/k} \qquad (4)$$

where:

T_2 = gas discharge temperature, °R.
T_1 = gas suction temperature, °R.
P_2 = discharge pressure, psia.
P_1 = suction pressure, psia.
k = constant

Although Equation 4 is not rigorous for an actual compression the temperature ratio obtained is suitable for use in this calculation.

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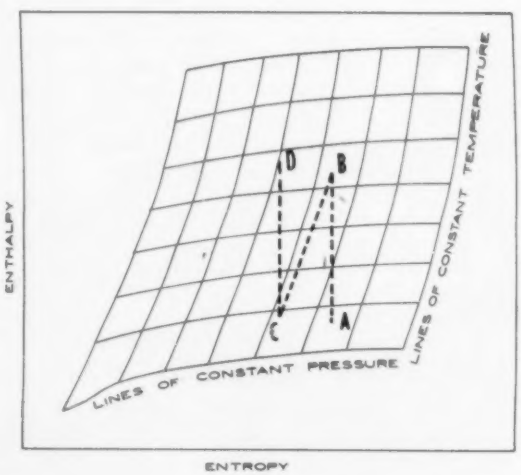

GENERAL application of enthalpy-entropy charts in compressor calculations. Fig. 3.

Seven new plants

proposed in East-Southeast area

A

• **American Oil Co.** will increase crude capacity 1,100 bbl. and straightrun asphalt 830 bbl. in third quarter 1958 at Savannah, Ga.

• **Atlantic Refining Co.** will complete a 20,000-bbl. visbreaker and increase capacity of vacuum unit charging topped crude 40,000 bbl. at Philadelphia in 1959. **Badger Manufacturing Co.** is contractor.

B

• **BP Canada, Ltd.,** will complete a $30,000,000, 25,000-bbl. plant at Ville d'Anjou, Que., by mid-1960. It will include a 15,000-bbl. cat cracker, a 9,000-bbl. cat reformer, a hydrodesulfurization unit, and a polymerization unit. **T. Lummus Co. of Canada, Ltd.,** has prime contract.

C

• **California Oil Co.** will complete December 1958, a 10,000-bbl. UOP Platformer-Unifiner at Perth Amboy, N. J. **H. K. Ferguson Co.** has contract. Crude capacity will be increased 10,000 bbl. and capacity of vacuum unit charging topped crude 5,700 bbl. by December 1958.

• **Canadian Petrofina, Ltd.,** will increase capacity at Montreal 50% to 30,000 bbl. by July 1958. Cost will be $3,000,000. **Procon, Inc.,** has contract.

• **Cities Service Oil Co. (Pa.)** will complete mid-1958, a 14,000-bbl. asphalt plant to replace existing facilities at Linden, N. J. **C. F. Braun & Co.** has contract.

• **Commerce Oil Refining Corp.** will complete July 1, 1959, a $48,000,000, 43,000-bbl. plant at Jamestown, R. I. It will include at 21,500-bbl. vacuum unit to charge topped crude, a 49,000-bbl. fluid cat cracker (50% recycle), a 10,000-bbl. Platformer, a 10,000-bbl. Unifiner, a 2,640-bbl. alkylation, 802 bbl. of catalytic polymerization capacity, 86 tons of sulfur, and 566 tons of coke. **Lummus Co.** handled some of the original process planning. **Fluor Corp., Ltd.,** has construction contract.

SHADED PORTION of map is area covered in this survey.

D

• **Delta Refining Co.** will increase crude capacity from 12,000 to 18,000 bbl. at Memphis, Tenn., before end 1958.

E

• **Elk Refining Co.** will increase Platforming 500 bbl. at Falling Rock, W. Va., by January 1, 1959.

• **Esso Standard Oil Co.** is adding a 15,000-bbl. Hydrofiner at Bayway, N. J. **Foster Wheeler Corp.** has contract.

H

• **Hess Transport & Trading, Inc.,** plans a new plant at Port Reading, N. J. **Lummus Co.** has contract.

I

• **Irving Refining, Ltd.,** will build a 36,500-bbl. plant at St. Johns, N. B., to process imported crude. **Bechtel Corp.** has contract to complete in 1960.

R

• **R. I. Refining Co.** plans a plant at Tiverton, R. I.

S

• **Seminole Oil Co.** has indefinite, long-range plans, for a $16,000,000, 15,000-bbl. plant at Fort Pierce, Fla., to be operated by Frontier Refining Co.

• **Socony Mobil Oil Co., Inc.,** will complete early 1959, a 19,000-bbl. delayed coker at Paulsboro, N. J. **Lummus Co.** is contractor.

• **Southeastern Refineries, Inc.,** plans a 5,000-bbl. plant at Savannah, Ga., to make asphalt from heavy imported crude. Cost is estimated at $1,900,000.

A complete report of all U. S. and Canadian process construction will appear in the Journal's midyear review and outlook report, July 28 issue. The report will include projects in refining, field processing, and petrochemicals.

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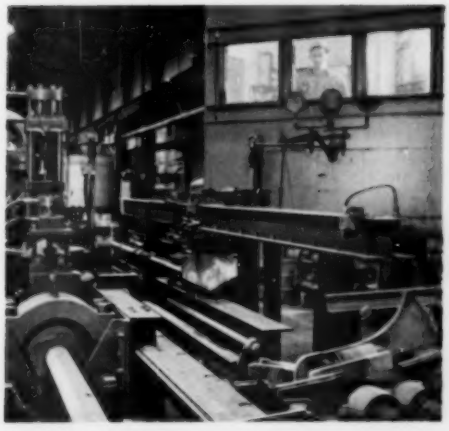

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Technical Editor and
Petroleum Consultant

In your answer of October 21, 1957, you showed average transportation rates for shipments from the Gulf Coast to the East Coast. Do you have similar data on other tanker ranges, and more recent data? Are such averages dependable? R.S.T.H.

More recent information on crude oil tanker rates is given in Fig. 1, and included are the following ranges

U. S. Gulf—U.S. No. Hatteras
N.W.I. —U.S.N.H.
N.W.I. —U. Kingdom
Persian G.—U.S.N.H.
Persian G.—U.K.

Note especially that SCALE Rates (not USMC) are used for shipments to the United Kingdom.

The 12-month running average (charter rates), and company-owned vessel rates (USMC — 10%) used along with the spot rates to obtain averages, are not shown. The basis employed in weighing these various rates was explained on the Questions on Technology page of October 21, 1957, p. 134.

Perfect averages of tanker rates will never be possible. However, it is felt that the average rates shown here are a proper general representation of the situation. Note how violently the spot or single-charter rates fluctuate. The cost of transporting oil in company-owned vessels and the cost by somewhat stable long-term charters tend to stabilize the fluctuating spot rates, giving the average rates shown on the lower part of Fig. 1.

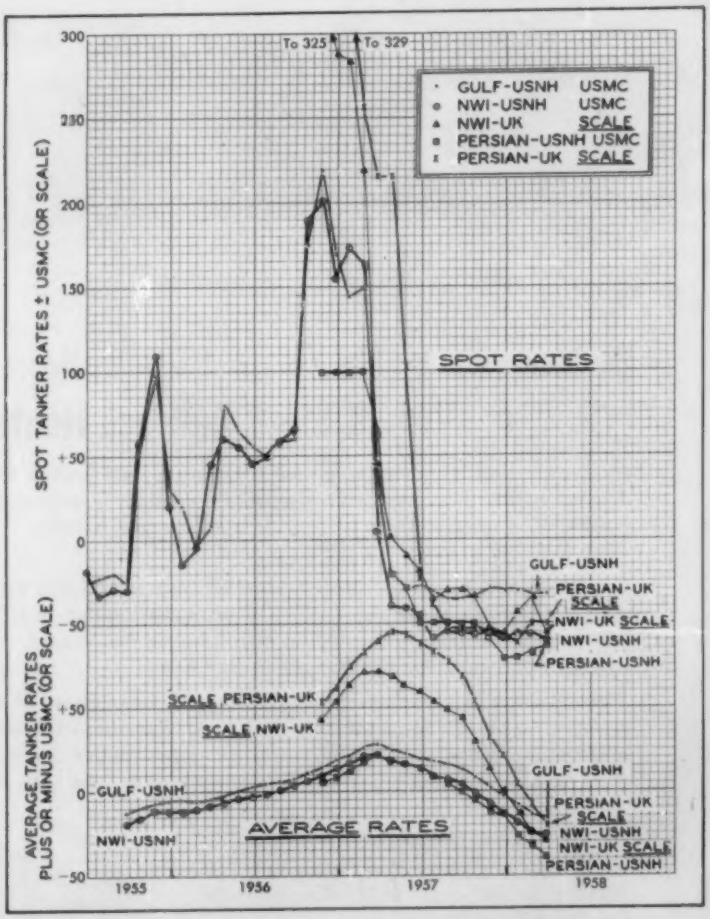


FIG. 1—Spot rates and average rates for tankers.

Why two kinds of octane numbers

Why do we have two kinds of octane numbers? G.P.D.

Ever since the first use of octane numbers we have been striving to relate laboratory tests to the performance of cars on the road. Under some conditions the motor method is most clearly related to road performance, whereas under other conditions both the research and motor test results must be used. During the years, a somewhat standard road test has been developed using a hill in Uniontown, Pa., and the results are called Uniontown Road Octane Numbers.

According to the excellent Du Pont report entitled "Road Ratings of Tomorrow's Gasolines in Tomorrow's Cars" (March 1957), road octane number can be predicted from the following:

Road O.N.=0.5 Res.+0.5 Motor +4.0.

When the very high-octane fuels (96-107) of tomorrow are considered, the same equation is obtained except that the constant becomes 4.5 rather than 4.0.

At high-speed conditions, motor octane numbers are more closely related to road performance than are research octane numbers. However, the best correlation occurs when the average of the research and motor numbers, less 0.1 times the percentage of olefins, is used as the correlation factor. The relationship is about:

Road O.N.=0.5 Res.+0.5 Motor —0.1 (% olefins)+4.5.

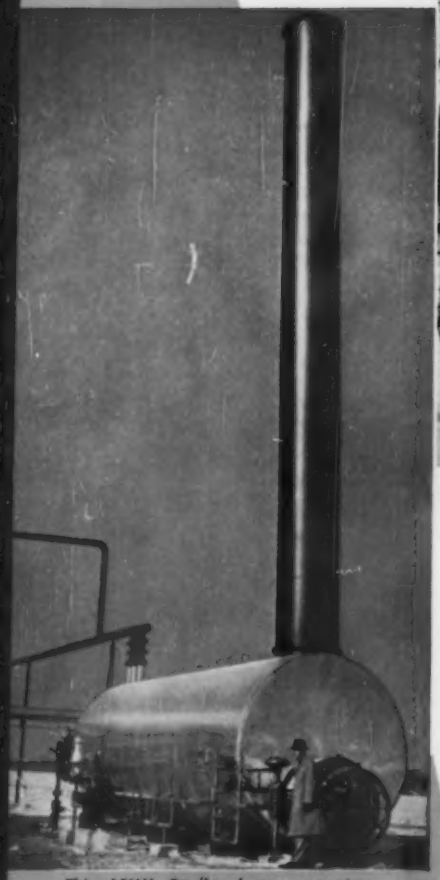
At low speeds, road performance is related to the average of the research and motor octane numbers as follows:

Road O.N.=10+0.952 (ave. of R&M).

The Du Pont report concludes that both research and motor octane numbers are needed in predicting road behavior.

This Gas Utility Company Shaves Peak Loads...

These two 10MM Btu/hr. heaters will vaporize approximately 10,000 gallons/hr. of LPG each. They are fired with natural gas, and are tied in with the complete automatic controls for mixing LPG, air and natural gas.



This 15MM Btu/hr. heater vaporizes approximately 15,000 gallons/hr. of LPG.

By Vaporizing Up To 35,000 Gallons/Hr. Of LPG With 3 BS&B Indirect Heaters!

As every gas utility company knows, there are several periods of peak demand which they may be hard-pressed to satisfy . . . unless they take positive and specific steps to provide a *reserve* gas supply when the need arises.

One large midwestern gas utility company* has solved this problem with the installation of three BS&B water bath indirect heaters which can vaporize butane and propane into the city mains at a rate of approximately 35,000 gallons per hour.

These heaters will handle the LPG at an inlet temperature of 10° F. and give an outlet temperature of 130° F. All are completely automatic, and require no operators except for an occasional routine check. During their first two years of operation, maintenance costs have been zero.

*Name supplied on request.

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P. O. Box 1714 Oklahoma City, Oklahoma

BY W. L. NELSON
Technical Editor and
Petroleum Consultant

Average cost of refinery steam since 1932

(Cents per 1,000 lb.)

	Boiler feed water*	Operating and maintenance labor†	Maintenance material‡	Fixed charges§	Total cost (excl. fuel)	Average fuel cost‖	Total cost — No reuse	Total cost — 20% reuse	Total cost — 60% reuse	Index steam cost
1932	1.9	0.7	0.2	1.5	4.3	15.1	19.4	16.2	12.1	31
1934	1.8	0.7	0.2	1.6	4.3	19.6	23.9	19.9	14.9	38
1936	1.8	0.8	0.2	1.7	4.5	18.8	23.3	19.4	14.6	37
1938	1.8	1.0	0.3	1.8	4.9	17.6	22.5	18.8	14.0	36
1940	1.8	1.1	0.3	1.9	5.1	17.1	22.2	18.5	13.9	35
1942	2.0	1.3	0.3	2.2	5.8	19.8	25.6	20.5	16.0	41
1944	2.0	1.7	0.4	2.3	6.4	22.3	28.7	23.9	17.9	46
1946	2.1	2.2	0.6	2.7	7.6	25.4	33.0	27.5	20.6	53
1947	2.5	2.3	0.6	3.2	8.6	35.2	43.8	36.5	27.4	70
1948	2.6	2.5	0.6	3.5	9.2	45.9	55.1	46.0	34.4	88
1949	2.4	2.3	0.6	3.6	8.9	33.8	42.7	35.6	26.7	68
1950	2.5	2.4	0.6	3.8	8.3	36.0	44.3	36.9	27.7	71
1951	2.7	2.6	0.7	4.0	10.0	40.8	50.8	42.3	31.8	81
1952	2.8	2.7	0.7	4.1	10.3	41.5	51.8	43.1	32.4	83
1953	2.9	2.8	0.7	4.3	10.7	44.6	55.3	46.1	34.6	88
1954	2.9	2.7	0.7	4.4	10.7	44.3	55.0	45.8	34.4	88
1955	2.9	2.7	0.7	4.6	10.9	47.5	58.4	48.6	36.5	93
1956	3.0	3.0	0.8	4.7	11.5	51.2	62.7	52.3	39.2	100
1957	3.0	3.2	0.8	4.8	11.8	55.0	66.8	55.7	41.7	106

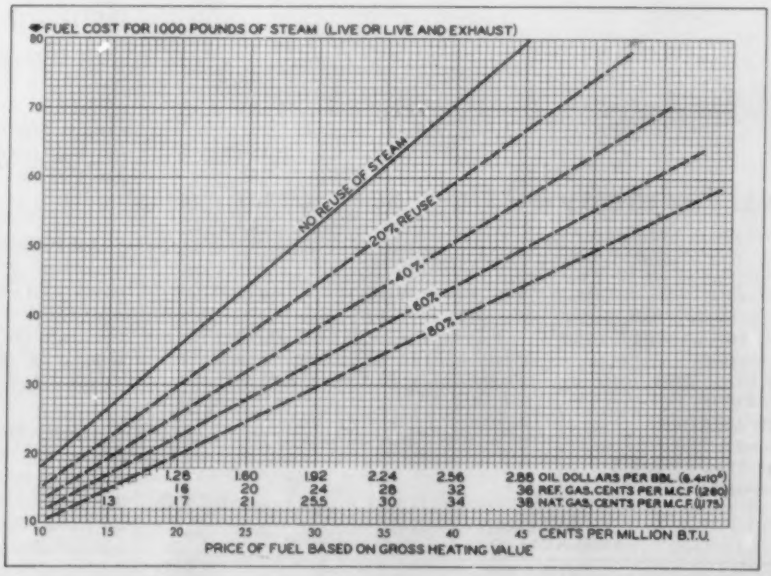
*Yearly values based on price of industrial chemicals, see quarterly Itemized Cost Indexes, The Oil and Gas Journal (January, April, July, and October).

†Maintenance labor is one-fourth of total labor.

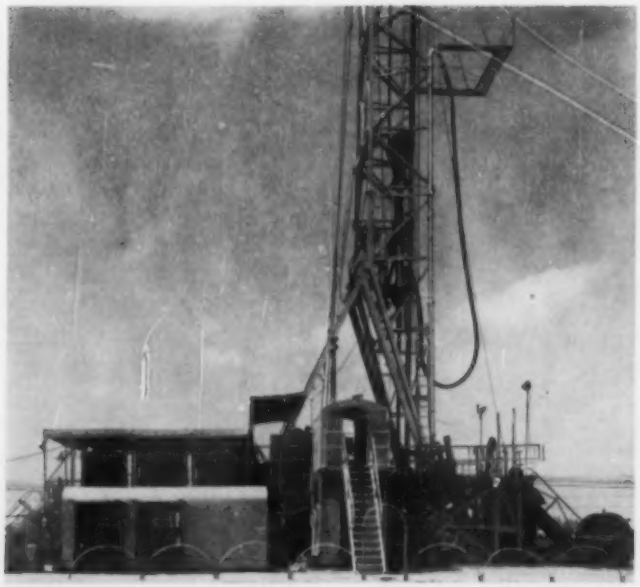
‡One-fourth of operating and maintenance labor.

§10% per year of replacement value (4% interest or dividends, 2% insurance and property taxes, 2% obsolescence and overhead). See Cost-imating No. 14 for costs of steam plants (July 16, 1956), and Cost-imating No. 22 (old series), March 17, 1949, for the cost of industrial buildings.

‖Average cost of fuels for United States refineries, Processing costs No. 4, March 17, 1958, p. 190.


FUEL COST FOR 1000 POUNDS OF STEAM (LIVE OR LIVE AND EXHAUST)
NO REUSE OF STEAM
20% REUSE
40%
60%
80%
2.88 OIL DOLLARS PER BBL. (6.4x10⁶)
36 REF. GAS CENTS PER M.C.F.(1280)
38 NAT. GAS CENTS PER M.C.F.(1175)
CENTS PER MILLION B.T.U.
PRICE OF FUEL BASED ON GROSS HEATING VALUE

Williston driller adds another rig



CALVERT DRILLING'S newly acquired rig goes to work in North Tioga field.

ONE of the more active contractors now working in the Williston basin of North Dakota and eastern Montana, Calvert Drilling, Inc., is extending its drilling activities in that region by the addition of another rig.

This makes five rigs Calvert is operating in the Williston basin. The additional rig, now working in the North Tioga area of Burke County, in northern North Dakota, is a used assembly recently acquired through Lucey Products Corp. It is a National 80-B, more than adequate for the current 6,000 to 8,000-ft. drilling depths of that area.

Addition of the rig is in line with the expansion of the company's operations generally. Included in this expansion has been the recent acquisition of An-Son Petroleum Corp.'s interests in 17 gas properties in the sprawling and steadily growing Laverne-Highland multiple-pay gas-productive area of Northwest Oklahoma's Harper and Beaver counties.

Calvert, along with many other companies, big and small, long has had its eye on the potentialities of the Anadarko basin of western and northwestern Oklahoma. It recently completed two deep wildcats in that region.

Who's getting the drilling contracts

Jet Drilling Co., Denver, has contract for a new wildcat 7 miles west of Monroe in Ouachita Parish, northeastern Louisiana. The 9,800-ft. Cotton Valley wildcat is Arkansas Louisiana Gas Co. 1 Ewell Camp, SE 29-18n-2e.

Ashby Drilling Co. is contractor for a wildcat in Logan County, Denver basin, Colorado. It is British-American Oil Producing Co. 1 Colorado "Y," C SW NW 16-11n-53w. The wildcat is on its way down to the Dakota-Cretaceous sands.

Gracey Hellums Corp. has contract for a 15,000-ft. hole at East Lake Palourde in Assumption Parish, South Louisiana. The well is Union Oil Co. of California 2 State Lease 3033. Location is in 35-15s-13e.

Rimrock-Tidelands Drilling Co. has

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—flexible end-member for wire rope

Each Boomer Chain has an ACCO drop-forged Grab Hook (I-beam type) on each end, attached at the factory and proof tested. Hook is of same material as chain.

Boomer Chains of High Test are available in six sizes, from ¼" x 20 ft. through ⅝" x 20 ft....packed one to a blue bag. Chains of Accoloy are made in four sizes, from ⅜" x 20 ft. through ⅝" x 20 ft....packed one to an orange bag.

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contract for a 10,100-ft. wildcat in Main Pass Block 49, offshore from Plaquemines Parish, coastal Louisiana. The well is Phillips Petroleum Co. 1 State Lease 2751.

Lewis Drilling Co. has contract for a wildcat in the Denver basin. It is Midwest Oil Corp. 1 Midwest-Lewis-Rasmussen, C SW SE 6-11n-56w, Weld County, Colorado. Projected depth is to 6,675 ft. for a look at the "J" Dakota-Cretaceous sand.

Deckard Drilling Co., Shreveport, has a rig under contract to George Belchic, Jr., for a 5,400-ft. test south of Heidelberg field, in southeastern Jasper County, eastern Mississippi. Location is for 1 Huddleston, in 10-10n-10w.

Armstrong & Horn Drilling Co. has contract for a 7,500-ft. wildcat in Gonzales County, South Texas. The well is Skinner Corp.-Armstrong & Horn Drilling Co. 1 Harry Chandler on Ben Davis Survey A-189, 8 miles southeast of Smiley and 2 miles northwest of the town of Sample, Tex.

Keith Mouser has contract for a cable tool Paleozoic wildcat 11 miles northwest of Morrilton in Conway County, Central Arkansas. The well is J. G. Beard Estate 1 Bertha Barrett, 22-8n-17w. Location is ¾ mile east of Old Hickory and 3½ miles southeast of Jerusalem gas field.

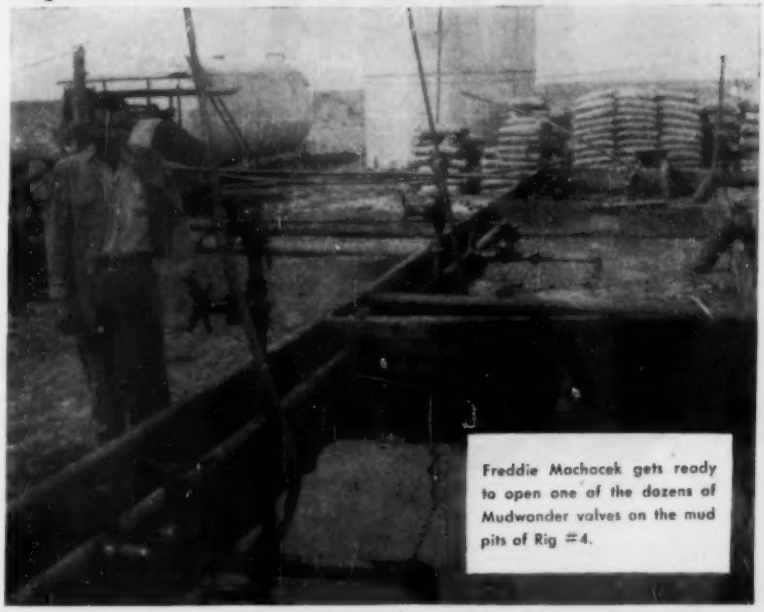
Cron & Gracey Corp. has contract for a 11,850-ft. well at Saturday Island, Jefferson Parish, South Louisiana. The well is Atlantic Refining Co. 3 State Lease 2955. Location is in 19-19s-25e.

Glasscock-Wilson Drilling Co. are contractors for a West Addis field well in West Baton Rouge Parish, South Louisiana. The new well is Aluminum Co. of America 1 S. P. Schwing et al. Oil Unit 2, 44-8s-11e. The well will go to 11,500 ft.

Gibson Drilling Co., Kilgore, is drilling Purnell & Coleman and associates 1 Mattie J. Barnett as a Woodbine wildcat in western Freestone County, East Texas. Location is 4 miles southwest of Teague in John Lloyd Survey, A-363.

Johnson Drilling Co., Tyler, has a rig running for W. H. Bryant 5 miles northwest of Slocum in southern Anderson County, East Texas. The project is 1 Lloyd Lassiter, a 5,700-ft. Woodbine wildcat in C. M. Carroll Survey, A-903.

Tips on Mud Valves for Toolpushers . .



Freddie Machacek gets ready to open one of the dozens of Mudwonder valves on the mud pits of Rig #4.

MUDWONDER Ideal for Versatile Service

by Freddie Machacek, Toolpusher, Rig #4
B.B.M. Drilling Company, Midland, Texas

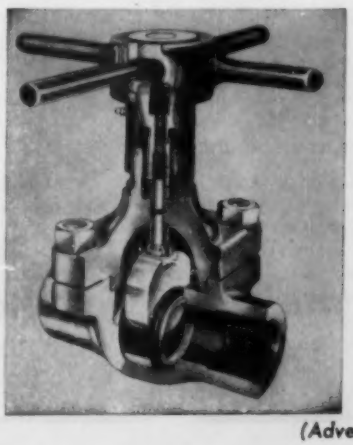
ABOUT two years ago I put a *Mudwonder* valve on our fill-up line just to see how it would make out. I soon found that *Mudwonder* worked fast and easily, without binding, even while bleeding off the line at 1600 lbs pressure. It did so well I tried more *Mudwonders* on the tough job of mud pit service—and they were so successful I've standardized on *Mudwonder* ever since!

Valves on mud guns and jets take a terrific beating, but we've had very little trouble with *Mudwonders.* As a matter of fact, our first ones are still in service; we replaced the stem packing on one valve—that's all! Because replacement parts are so easy to identify, we never have any trouble getting the exact part we need. In fact, the valves are designed to use the same seat and gate for both pressure classes.

When we have to dress a *Mudwonder,* the job can be done without disturbing any connections. The valve is out of service only about 10 minutes, start to finish, regardless of size. Another thing—they never sand up. Bob Lawrence, Edward *Mudwonder* Representative, says this is because the design causes the mud to flush the bonnet automatically.

Mudwonder valves are available in 2", 3" and 4" sizes; with screwed or flanged ends; rated at 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test). See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

Mudwonder cut-away view shows the one-piece seat insert, with Buna-N molded integrally over steel wear rings; chromed gate with "T" slot connection; separated stainless stem and double thread construction.



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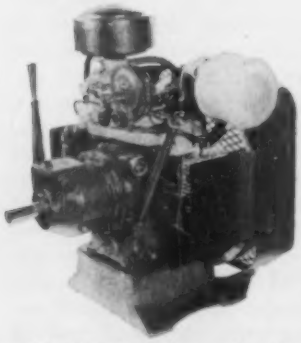

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THE OIL AND GAS JOURNAL

Box 1260 . Tulsa, Oklahoma

Here's the way to proper

Meter Calibration

The author says . . .

In this day and age of automation, we in the pipeline industry are looking at the meter as an office manager would examine a business machine. It will not be long before meters will take the energy from the stream that moves its counting mechanism, correct the total meter reading for temperature and meter factor, totalize the meter readings of a number of meters on one ticket, produce a punch card for the end results, and even allow an operator to calibrate the master-meter method without leaving the control room.

By M. A. LEVY
Supt., Products Movement,
Southern Pacific Pipe Lines, Inc.,
Los Angeles

THE EFFECT of viscosity on meter factors in refined product service is being dealt with by setting up strict calibration procedures where pipeline meters are calibrated.

Some of these strict regulations which require recalibration are: (1) whenever there is a meter failure, (2) whenever a meter part is changed, (3) whenever the gravity changes 3° API, (4) whenever switches are made from one type product to another (such as gasoline to kerosine), and (5) after a 1-week interval of service.

This calibration procedure, which automatically correlates gravities to viscosity, correspondingly decreases the importance of the viscosity factor. We also find that in areas where a particular pipeline operates, the base stock is essentially the same and, therefore, the viscosity of similar products produced from it are the same.

The common trend in the pipeline industry today is to streamline the design to take the entire stream of a gathering system directly into suction through positive-displacement meters equipped with dual printing heads. In contrast to a six or eight-meter bank system, design engineers are looking toward a two or three-meter bank system. In two-meter system, each meter would be capable of full-line stream capacity with the second meter being used to guarantee continuity of operations; while in the three-meter setup, the full-line stream rate of the pipeline would be normally divided between two meters with the spare unit being used for guaranteeing continuity of operation.

Calibration Methods

The first question that then arises is, "How is calibration accomplished without starving downstream stations when one-half of the stream is being diverted to the prover tank?" Two simple but apparently wrong answers would be to build in enough spare capacity at the suction side of the measuring point to accommodate the flow diverted from the line to the prover tank, or to install a greater number of smaller meters in parallel with one another, and in so doing decrease the percentage of line flow to the prover tank.

Should more meters be installed, the pumps and the gathering system supplying suction to the main line could be designed to handle a smaller load. The latter solution is the better one; however, its cost is prohibitive from a maintenance and labor standpoint, and defeats the purpose as far as simplicity in design is concerned.

Methods developed to decrease or eliminate the start-and-stop method of calibration are:

1. The use of centralized calibration.
2. The use of the master-meter method in connection with the gravimetric (weight method).
3. The use of the master-meter method in connection with the use of the prover tank (volumetric method).
4. The use of a prover section built directly into the pipeline (measured mile).

Atlantic . . . Atlantic Pipe Line Co., to avoid pressure surges in its main line as a result of start-and-stop meter-calibration procedures, uses a centralized meter-calibration system located at its Montello station near Reading, Pa.

This meter station is separate and apart from main-line operations and is the point where all meters are calibrated for a specific district. Calibrations are accomplished by stocking a number of spare meter rotors (double-case meters) rather than going to the expense of permanently installing spare meter equipment.

Atlantic's meter rotors are calibrated at regularly programed intervals except in cases of mechanical failure. During each calibration of the rotor, entire performance curve computations are made (flow rate against meter factor rather than flow rate against per cent accuracy) for gasoline, and the obtained mechanical factor corresponds to the rate of flow.

Considerable tests have been run on kerosines and diesels, and it has been established that the mechanical factors on kerosine and diesel can be obtained by deducting a predetermined experience factor for kerosine and for diesel from the mechanical factor obtained on gasoline at a given rate of flow. Very satisfactory results have been obtained from this method of calibration.

General Petroleum . . . General Petroleum Corp. employs at their Vernon installation in Los Angeles the master-meter method in conjunction with the gravimetric proving method to calibrate its meters. The specific gravity of the fluid is accurately determined by the Westphal balance.

Approximately 55 bbl. of product

Presented at ASTM symposium on methods of quality measurement, Houston.

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is allowed to run through the master meter into a weigh tank, and after the barrels registered by the meter are converted to pounds, the weight through the meter is divided into the weight of product in the tank. The resulting quotient is the mechanical factor for the master meter. Other meters to be calibrated are placed in series with the master meter in the same manner as explained previously, and a mechanical factor for each meter is determined.

Plantation . . . Plantation Pipe Line Co., because of the long and complex gathering systems connected to their input station at Baton Rouge, La., receives all product into Baton Rouge by tank gage excepting where overlapping schedules or handling new products cause product to be pumped directly from the refinery into the pipeline. All pumpings into the pipeline and deliveries from their system are accomplished through positive-displacement meters.

To use its personnel to the fullest extent and still obtain the accuracy range required, Plantation uses the master-meter method of calibration, and also at Greensboro, N. C., a modified type of the master-meter method. The master-meter method of calibration is accomplished by placing another meter in series with the master meter, which has been calibrated by the prover-tank method.

Then at least 100 bbl. are run through the master meter and the meter in series with it. Dividing the observed barrels by the meter to be calibrated into the master-meter barrels corrected for the mechanical factor, the resulting quotient is the factor for the meter being calibrated.

At Greensboro, N. C., through a unique piping arrangement, low-capacity meters are manifolded in parallel with each other and in series with a high-capacity meter. The low-capacity meters are calibrated by the prover-tank method, and after the factor is obtained on each of the low-capacity meters, they are lined up in parallel to each other and in series with the high-capacity meter to be calibrated. In this case 200 bbl. are allowed to run through the high-capacity meter with the stream evenly distributed between the two low-capacity meters. The mechanical factor for the high-capacity meter is obtained in much the same manner as described heretofore.

Shell . . . Shell Oil Co. has altered the conventional type of prover system by incorporating into their system a measured portion of the pipeline often referred to as the "measured mile" or "miracle mile." This "built-in section" is located either on the suction or discharge side of the measuring point, and does not necessarily have to be a mile in length but long enough to assure an accurate meter factor.

Custody transfers (hand-written tickets are now being used, but these tickets could be adapted to the printers installed on the meter) are being made from Sun Oil Co., The Texas Co., Cities Service, and Shell to the pipeline.

This installation consists essentially of launching and receiving scraper barrels equipped with conventional tripping mechanisms for starting and stopping a meter's register by the use of an electrical circuit, and incorporates the idea of a tight-fitting piston (scraper) displacing product from a cylinder.

Workable Size

A workable size for the meter-proving section should be approximately one-tenth of the normal flow in barrels per hour through the meter or meters to be proved, but in no case less than 10,000 times the least reading of the meter's register so as to determine the registered quantities to within 0.01%.

Each meter is equipped with a reg-

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do it once — do it right!

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Eliminate those costly "re-cuts" and "re-fits" with an H&M Shape Cutter. Then—do it once, and you've done it right!

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TULSA, OKLAHOMA

ister composed of two counters: the totalizer counter, which operates continuously to record the cumulative flow of the fluid passing through the meter; and the calibration counter, which is automatically motivated by a solenoid actuated by tripping devices. The prover section volume is very carefully checked by the use of a scraper (same type to be used for subsequent meter calibrations) and by a master meter which has been previously calibrated by the conventional prover-tank method.

Because the same type scraper is used for the prover-section calibration and for subsequent meter testing, any error in factor due to slippage across the scraper would be canceled. The actual calibration procedure consists of merely launching a scraper from one scraper trap to the receiving barrel.

The base volume of the prover section is corrected for average temperature and pressure recorded at the tripping devices, and this volume is divided by the total registration (corrected for temperature) appearing on the calibration counter of the meter to obtain the mechanical factor for the meters.

Although the initial cost of this system may offer disadvantages, it is the most practical method today of utilizing a calibrated section of its pipeline as a prover tank. In so doing it proves meters without diverting the stream from the pipeline and inducing pressure surges in the pipeline.

In some cases where distances between stations are small, a modified application of the metered-mile principle can be used by installing one measured section on the discharge side of one station and on the suction side of the downstream station. This decreases the initial high costs of two scraper-trap installations.

As can be seen from a aforementioned methods of meter calibrations, each pipeline operator has followed the principles advocated by the API Code 1101 but has adapted them to fit his own particular problems. Each of these methods or a modification of any one of them produces the same end results. With this in mind, it is imperative that the new code be written not as a directive, but in general terms so as not to stifle the imagination of the industry's members but to continue to promote and stimulate creative thinking.

Future Trends

Plantation Pipe Line is working on an installation at Bremen, Ga., which would take the registered total of seven meters on a meter bank, correct them for temperature and for mechanical factor, accumulate the corrected total, and transfer this total to one register located in the control room. This is accomplished by a signal generator, geared directly to the shaft of each meter, which drives selsyn motors; and, through reduction and differential gearings, produces a continuously corrected meter reading.

Also installed in this equipment is a comparison unit which is used to make instantaneous calibrations. The meter factor for the master meter is predetermined by the normal procedure of calibration by the prover-tank method. The meter to be calibrated is then placed in series with the master meter.

With the master meter and the meter to be calibrated in series with one another, the output of their correction units driving the selsyn motors of the comparison unit sets up an electrical comparison between the corrected meter and the meter to be calibrated.

The difference of the two meter results is indicated by a sweep line on cathode ray tube. Corrections are made by switching in and out differential and reduction gearing until the sweep line stops or rotates at the slowest speed. At this time the meter to be calibrated is correct to four decimal points as compared to the master meter.

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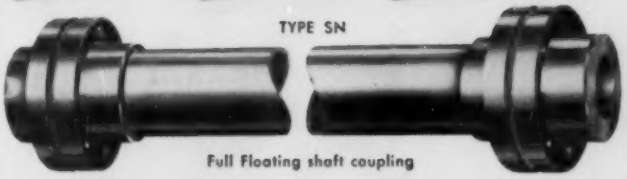
ALL METAL

NO LUBRICATION · NO MAINTENANCE · NO WEARING PARTS



Full Floating shaft coupling

REFINERS! PIPE LINE MEN! DRILLING ENGINEERS! LABORATORY TECHNICIANS!

Thomas Couplings are used to advantage on Pumps, Compressors, Cooling Towers, Rigs or any other tough job where continuous operation and dependability are required.

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UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

1 Freedom from Backlash Torsional Rigidity
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3 Smooth Continuous Drive with Constant Rotational Velocity
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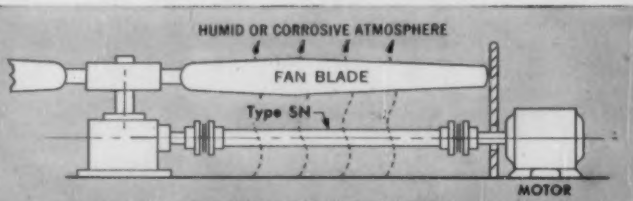
5 Original Balance for Life
6 No Lubrication
7 No Wearing Parts
8 No Maintenance



COOLING TOWER INSTALLATION

In the typical cooling tower installation shown above, the motor — outside the humid or corrosive atmosphere — is connected by a floating-shaft coupling to the gear box under the large slow-speed, horizontal-blade fan.

Write for engineering catalog 51A, and the name of your nearest Thomas representative

THOMAS FLEXIBLE COUPLING COMPANY

WARREN, PENNSYLVANIA, U.S.A.

This week's SHOWCASE features . . .

Ditch-padding machine eliminates

. . . earth hauling. The machine is adaptable to a ¾-cu. yd. dragline. It has been proved by extensive field tests on oil, gas, and water pipelines. Though recently invented, the machine has undergone major improvements which far surpass the original design, according to the maker.

It consists of an endless steel-wire grid, 6 ft. wide, rotating on a shaker-track system which loosens dirt from rocks in the spoil. A backfill bucket drags the spoil onto the grid which is suspended across the ditch by the dragline boom. Fine dirt is shaken through the grid and onto the pipe. All rocks larger than the grid openings are conveyed across to the working side of the ditch. Even damp earth is sifted through the grid.

The dragline operator controls and operates the machine from his cab chair. **Write or call: Crutcher-Rolfs-Cummings, Inc., P. O. Box 2073, Houston, for details on ditch-padding machine.**

Send this **Showcase Coupon**

to the Manufacturer of the item in which you are interested. See name, address, and equipment name and/or model, in bold-face type at end of description.

NAME AND/OR MODEL NUMBER.....

.....

.....

Described in OIL AND GAS JOURNAL - Issue of June 30, 1958

NAME.....TITLE.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

DATE.....

Plastic slurry aids water shutoff

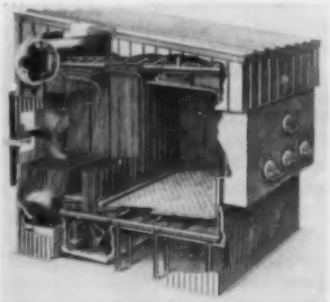
. . . in air and gas drilling. Designated PC-11, the product is one of two new Halliburton materials developed for remedying the problem in air and gas drilling of controlling the flow of unwanted water. The other is a polymeric water gel, designated PWG.

The products are not related chemically. Instead, they offer two ways to attack the same problem. The plastic slurry is especially effective for water shutoff in fractured formations producing moderate to large amounts of water, the maker reports. Use of the other, PWG, is indicated when water from a permeable formation is encountered.

PC-11 consists of a thermosetting plastic and solids used as bulking agents and for fluid-loss control. Relatively long sections of water-producing horizons can be treated with it. It sets in 1 to 3 hours after contacting formation water.

The other water shutoff agent, PWG, has a low viscosity. The low viscosity is maintained during its pumping life and aids entry into the true permeability of the water-bearing formation. When the material enters its setting stage, a stiff gel forms in less than an hour. **Write or call: Halliburton Oil Well Cementing Co., Duncan, Okla., for details on plastic slurry and water gel.**

●



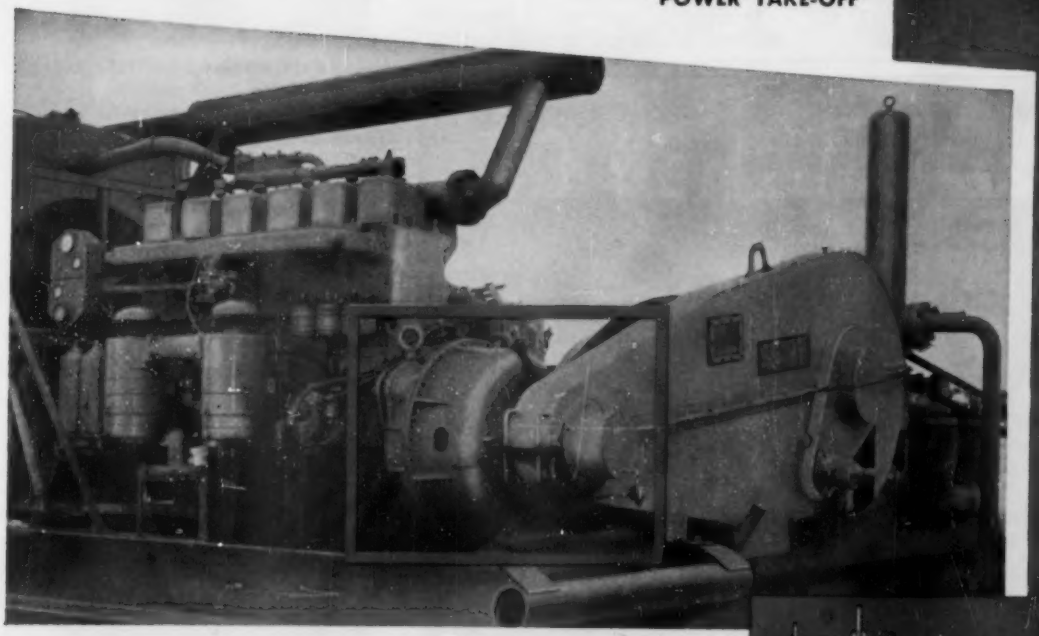
Steam generator burns oil or gas

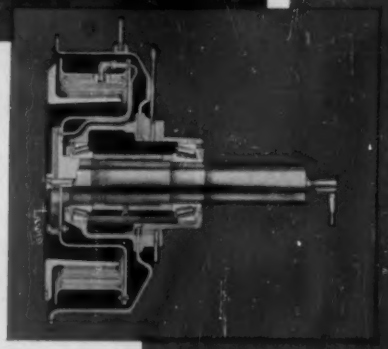
. . . and furnishes up to 400,000 lb. of steam an hour for process or heating loads. The boiler offers an advanced design in "membrane wall" prefabricated-furnace construction, which uti-

Air Controlled Shock-Free Operation with FAWICK PTO*

*POWER TAKE-OFF

Another Field-Proved Product Supplied by Mid-Continent





Air operated Fawick PTO has self-adjusting CB air-flex clutch and rugged anti-friction shaft bearings.

The air operated Fawick Power Take-Off provides an ideal shock-free independent pump drive and may be remotely controlled from the driller's position. Heavy duty bearings and rugged bell housing eliminate the need for pilot bearing or outboard bearing. The Fawick PTO offers dollar savings in initial installation too, because it requires no special adapters, skids or outboard bearings. It bolts directly to the engine flywheel and flywheel housing. V-belt or chain drives are easily installed or removed from the open end clutch shaft, speeding up rig-up time. For complete information on the Fawick PTO, contact your Mid-Continent representative. Mid-Continent stores, sales offices and sales representatives are located in all active oil areas.

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THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY

lizes welded, tubular-furnace wall panels.

High efficiency and the elimination of an induced-draft fan are accomplished through the pressurized-furnace design, with a subsequent savings in fuel, fan, and power costs, the maker claims. Boiler operation is said to be simplified because there is only one fan to operate and maintain.

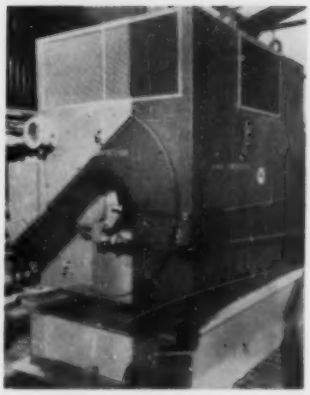
Designated the PFI, the boiler is available for steam pressures to 1,150 psi. and for superheated steam temperatures up to 900° F. **Write or call: Babcock & Wilcox Co., 161 East Forty-second Street, New York 17, for details on PFI steam generator.**

Open type of motor easily kept up

. . . in refineries and pump stations. It's suited to a numbr of outdoor applications in the petroleum industry, the maker reports. Called the Super-Seal, the motor employs a homogeneous, vulcanized coil structure.

This type of coil structure overcomes the need for total enclosures or special ventilating schemes. The windings are easily accessible for cleaning. They can be cleaned by washing with detergent and water.

If repair is necessary, a throw of the flexible coils can be lifted and the



damaged coil removed. Or, if the damaged area is readily accessible, repair can be made without removing it from the winding.

After a coil is taken out, the break is patched with uncured silicone rubber that is heat vulcanized to the original coil insulation. **Write or call: Allis-Chalmers Mfg. Co., Milwaukee 1, for details on Super-Seal motors.**

●

Pneumatic relay solves equations

. . . continuously by combining two or more pneumatic signals in varying, predetermined proportions. It multiplies or divides one pneumatic signal representing a measured variable by some predetermined function of a second variable. And it adds and subtracts pneumatic signals and provides proportional-control action.

In process plants, it's well suited to the ratioing of two flows in multi-element control systems and to pressure-temperature compensation of liquid or gas-flow measurement.

The computing relay uses standard SAMA ranges of 3-15 psig. and 3-27 psig. Approximate size is 8½ by 11 by 9 in. deep. The function-generating cam is easily shaped on the job. **Write or call: Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, for details on new pneumatic relay.**

STEEL Any type— any time

cuts costly delays

Carbon steel—bars, structurals, plates, sheets, tubing.
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Rubber-sleeve core barrel

. . . is designed to obtain higher quality cores in unconsolidated formations, conglomerates, or badly fractured rock, the maker reports. It holds a loose core together. And it protects the core from damage by moving fluid. It packages the unconsolidated core so it can be handled easily and transported with little disturbance.

The barrel operates at the end of a conventional drill string. It is rotated by the rotary table. Circulating fluid provides the weight for cutting the core. It is controlled by the flow rate of the pumps and the number of nozzles open in the nozzle plate. Core barrel diameter is 6⅞ in. o.d. Core size is 3 in. Available in a 38 ft. length, the barrel takes a 20 ft. core. Diamond-bit sizes range from 7½ to 9⅝ in. o.d. **Write or call: Christensen Diamond Products Co., P. O. Box 387, Salt Lake City 10, for details on rubber-sleeve core barrel.**

●

Air hammer eliminates dust

. . . in drilling concrete, brick, plaster, or other masonry. Called the 15-DL, the utility drill pulls in the drilling dust through hollow drilling steel. The dust then moves out ports in the back head of the tool and into dust-extracting tanks. The air hammer is offered with hollow steels and bits in sizes from ⅞ through 1⅜ in.

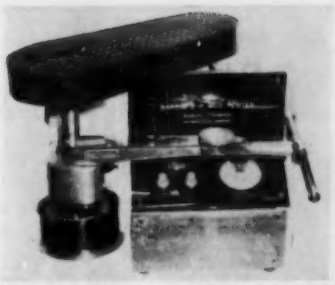
The dust extractor consists of three durable-plastic dust-collecting and air-filter tanks. These mount on a caster-wheeled cart for easy moving. **Write or call: Thor Power Tool Co., Prudential Plaza, Chicago 1, for details on 15-DL air hammer.**

Extreme-pressure drilling mud

. . . tester allows on-location determination of a mud's lubricating properties.

It enables field personnel to make immediate, reliable recommendations of the amounts of E.P. additives needed to maintain desired lubricating properties of the drilling fluid, the maker points out.

Portable and compact, the unit weighs about 50 lb. Less than a pint of mud is needed for a test. The tester is powered by a 110 volt a.c. or d.c. motor. **Write or call: Baroid Div., National Lead Co., Testing Equipment Dept., P. O. Box 1675, Houston, for details on extreme-pressure drilling mud tester.**



30 Hartzite Plastic 12 ft. Cooling Tower Fans have been in continuous operation for 16 years at Sinclair Refining Company, Corpus Christi, Texas, without a single blade or hub replacement.

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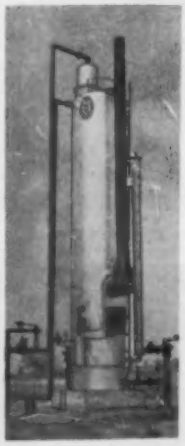

MFD BY M&V TANK COMPANY WICHITA FALLS TEXAS

TYPE P-V
PRESSURE
TREATERS

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Wichita Falls, Texas
TANKS - TREATERS
SEPARATORS
Steel Fabrication
for the Oil Industry

Graphite rupture disk for 300 psi.

. . . is now available for mounting in ASA 300 flanges. Six burst ratings are available in increments of 25 lb. from 175 to 300 psi. The Impervite rupture disk is accurate to ±5% of rated burst, the maker reports. It is unaffected by action of all corrosives except a few highly oxidizing ones.

Burst rating is independent of temperature change. The disk is suitable for use in any pressured or vacuum process to protect vessels against rapid or gradual buildup of overpressure, according to the maker.

It can also be used to protect storage tanks, special pressure enclosures, and similar equipment. It can be installed with pressure relief valves to limit product loss in event of rupture. **Write or call: Falls Industries, Inc., Aurora Road, Solon, Ohio, for details on ASA 300 rupture disk.**

SHOWCASE . . .

New Equipment

Motion indicator for process plant

. . . use where positive indication of motion or lack of motion is required. The new protective device is called Roto-Guard. It's a means of converting motion into a signal. The signal impulses may then be used to energize an alarm system to warn operating personnel or to operate control switches automatically. It can be used to prevent costly damage to materials or machinery in remote or obscure places.

The mechanism connects to any slow-turning shaft. As long as the shaft rotates normally, the Roto-Guard, by means of a circulating pump and pressure-actuated switch, indicates normal operation. If the rotation of the driven shaft slows below operating level or stops entirely, the resulting drop in pressure sets off an alarm signal. An operator can then take steps to prevent damage to other machinery. **Write or call: Bin-Dicator Co., 13946-140 Kercheval Avenue, Detroit 15, for details on Roto-Guard indicator.**

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Exclusive construction assures tight leak-proof closure fully up to operating setting—quick opening—and extremely high flows even at low pressures.

Oceco V-130 Conservation Regulators provide **greater flow capacity, size for size, and pressure for pressure, specially at low pressures than ever available before.** Our exclusive construction prevents vapors from escaping at less than set operating pressures. Flexing of the membrane peels off any icy formations, preventing freeze-ups. These valves bring never before secured all weather economy and dependability to the conservation of volatile products stored in cone, round, flat, lifter or expansion roof tanks. **Write for Bulletin No. 552. It gives full details!**

Patent Applied For.

PRESSURE BALANCED CONSTRUCTION

Tank pressures exerted on both sides of the membrane keep membrane under tension —assures tight seating fully up to operating setting—and positive flexing that peels away icy formations preventing freeze-ups.

EXCLUSIVE OCECO FEATURE SAVES YOUR VAPOR DOLLARS

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Portable instrument inspects pipe

. . . and equipment without disassembly. The portable Type US Reflectoscope for ultrasonic inspection is designed to operate at 2.25 mc. It weighs only 35 lb. and measures about 9 in. wide, 19 in. deep., and 14 in. high. Cost is below $2,500.

Field use is made simple through the use of only four control knobs. The unit provides a bright picture and an easily read video trace.

A transistorized automatic alarm is readily attached. **Write or call: Sperry Products, Inc., Danbury, Conn., for Bulletin 50-136.**

2,000-hp. hollow-shaft motor available

. . . for indoor and unprotected outdoor pumping applications. The vertical hollow-shaft motor design offers compactness for space savings and handling ease, the maker says. And it incorporates the most-recent advances in insulating materials. These materials provide high resistance to moisture and chemical contaminants. And they have high mechanical strength.

Bearing inspection takes about 5 minutes. Little cooling air is required. Thus air velocity can be kept low, preventing dust and moisture from being drawn into the motor by the air stream. Ninety-degree bends in the airflow system keep out snow and rain. Noncorrosive screens prevent entrance of foreign matter and rodents. **Write or call: Louis Allis Co., Dept. P, Milwaukee 1, for Bulletin 2450.**

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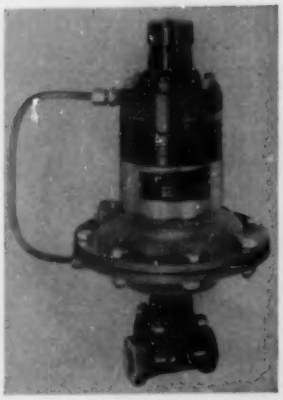

Valve controls flow of slurries

. . . or other hard-to-handle fluids, including acids. It's an air-operated diaphragm-control valve. Called the Type 900, the valve will control any fluid that can be pumped at temperatures to 400° F. and pressures to 150 psi., without plugging, the maker claims.

Employing a top-mounted positioner, it is available in either direct or reverse-acting models in a wide range of materials, including cast iron, stainless steel, and plastic (PVC). Diaphragm materials include abrasion-resistant rubber and Teflon. **Write or call: Uniflow Valve Corp., Cranford, N. J., for details on air-operated diaphragm-control valve.**

•

Microwave radio station

. . . with 24 channels has been developed for point-to-point communications. The maker claims it provides five times as many channels as previous one-package systems. It can be inexpensively pole-mounted.

The equipment gives 24 channels for voice communications, facsimile transmissions, teletypewriter, and remote-control functions.

For relays over long distances, two of the packaged stations can be mounted back-to-back. **Write or call: Communications Equipment Sales Department, Industrial Electronic Products, RCA, Camden, N. J., for details on MM-9E radio station.**

New 1958 revised . . .

U. S. POOL MAPS

Here are 17 completely up-to-date maps of the most active oil areas in the United States. Shows both oil and gas pools.

These maps are lithographed in three colors and give locations and names of both oil and gas fields.

Small scale—Journal page size—conveniently bound for ready reference in field or office. County and township lines make easy plotting of new wildcat locations.

Areas Covered: 1) California, 2) Intermontane Basins, 3) Northern Wyoming, 4) Williston Basin, 5) Kansas, 6) Julesburg Basin, 6a) Four Corners Area, 7) Hugoton Area, 8) Oklahoma, 9) North and East Texas, 10) Permian Basin, 11) West Gulf Coast, 12) South Texas, 13) East Gulf Coast, 14) Miss.-La.-Ark., 15) Tri-State Area, 16) Michigan.

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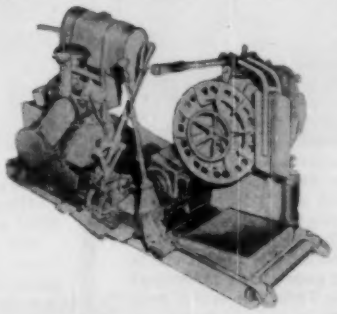

With 11.1 H.P. Waukesha 2 cylinder 4 cycle Gasoline Motor. Develops power for 3000-6000 pound load. Pulls 3000 pounds 50 feet per minute, 1500 pounds 100 feet per minute or equivalent combinations. The Winding Drum is a single casting, having two sections, one for the operating line and the other for storage. Overall capacity of the Drum is 400 feet of ⅜" diameter cable or equivalent amounts of other sizes, (other size Drums available). New, war surplus. Net weight 1070 lbs. Shipping weight 1650 lbs.

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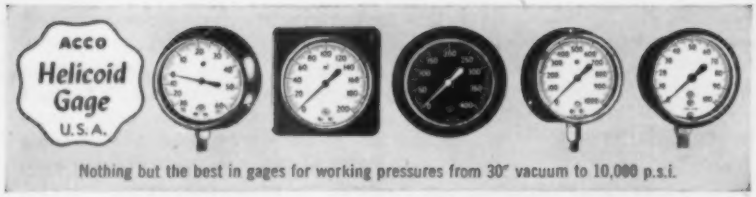
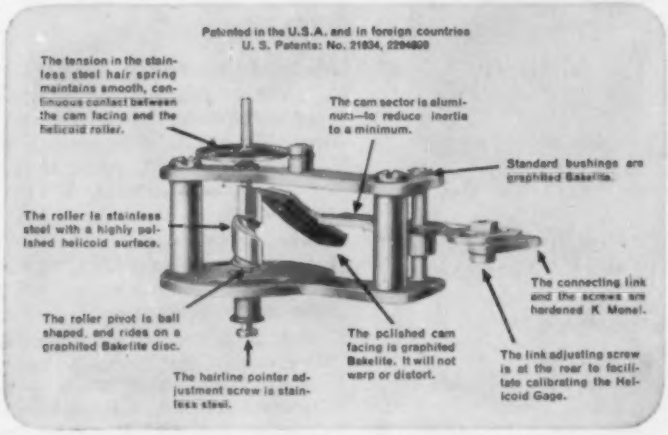
Established 1902



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21834, 2294800
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

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ACCO

SHOWCASE . . .

New Literature

Industrial stainless-steel pumps

. . . that have new design features for efficient, dependable operation—for pumping all kinds of corrosive materials in virtually every process industry—are described in new Bulletin 258-1. New design features include: volute type of pump head, Francis type of impeller, and spacer type of couplings. Specifications include all pump dimensions and descriptions of four different seal arrangements. Pump capacity curves are included. **Write or call: Ladish Co., Tri-Clover Div., Kenosha, Wis., for Bulletin 258-1.**

Nozzle safety-relief valve

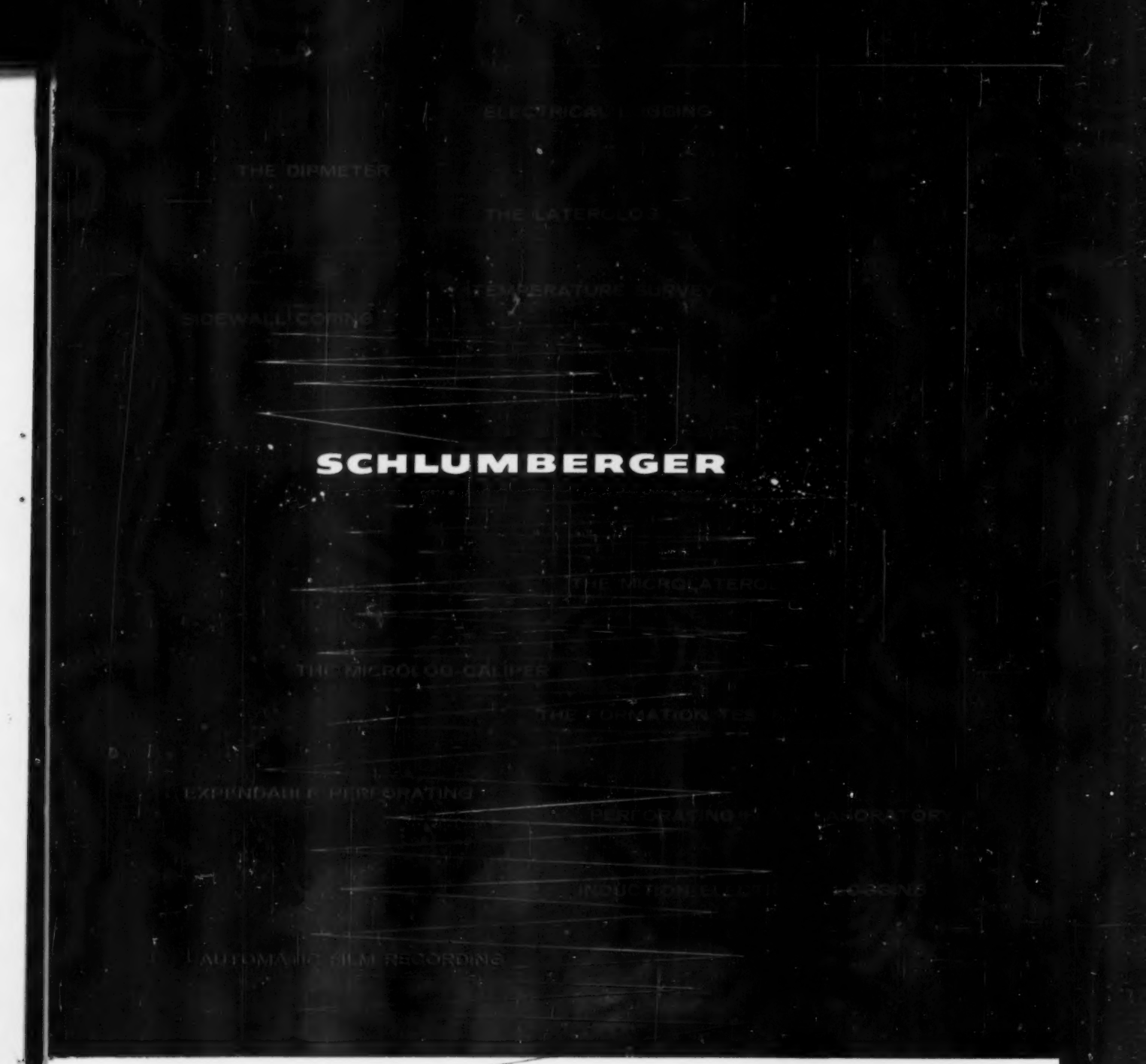
. . . sizing and selection is included in new Catalog 118. Included in the 44-page catalog is information on both the Farris standard and BalanSeal bellows varieties of safety-relief valves. A complete data section contains sizing factors and formulae. Nozzle capacity charts for air, water, gas, and steam, and dimension and weight tables are included. **Write or call: Farris Engineering Corp., 527 Commercial Avenue, Palisades Park, N. J., for Catalog 118.**

Mercury-vapor lighting fixtures

. . . that are explosionproof and dust-ignitionproof are described in new Bulletin 2705. The bulletin lists explosionproof fixtures with five styles of reflectors, all available with or without guard. Two styles of dust-ignitionproof lights are also listed. Mercury-vapor lamps provide high light output and long lamp life, the maker says. They are useful where long hours of burning are common. **Write or call: Crouse-Hinds Co., Syracuse 1, N. Y., for Bulletin 2705.**

New model-component catalog

. . . lists materials and parts designed to simplify construction planning of chemical and petrochemical plants, refineries, and layout equipment. These model components and materials represent a simple, inexpensive way to fabricate and assemble vessels, pumps, compressors, and heat exchangers, and arrange piping in three dimensional layout for study and approval. Using the new Uni-System method, construction of these planning models is simple and relatively permanent. No scale is shown, but the range of



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Many of these huge tankers make trips of three to four-hundred miles per day over highways which subject them to almost continuous shock and vibration. USS "T-1" Steel is relied upon to provide brawn as well as bonus payload.

Simple arithmetic with USS "T-1" Steel:

3,470 lbs. deadweight saved = 815 gals. more payload per trip!

That's the story in a nutshell of this mammoth LPG transport, manufactured by Trinity Steel Company of Dallas, Texas. Its 9,000-gallon tank is fabricated entirely of USS "T-1" Steel, and weighs only 12,130 lbs.—a reduction of 3,470 lbs. Translated into gallons of propane, 3,470 lbs. saved equals 815 extra gallons of payload carried. Thus, a transport making 300 trips a year can haul 244,500 more gallons than a unit of conventional design.

Since a hauler nets about one dollar per year per pound of deadweight saved, and the life of the tanker will be about 10 or 12 years, a weight saving of 3,470 lbs. will amortize the cost difference of "T-1" Steel several times over.

Trinity Steel manufactures three sizes of "T-1" Steel tanks, each custom-made to fit the gross weight requirements of the state or states in which it will operate. The tank shown here is 7 feet by 34′4″. Working pressure is 250 psi, although tested out at 500 psi. Thickness of the "T-1" Steel shells is only .419″ and the heads .250″. All parts are made of USS "T-1" Steel, including the shells, heads, openings, fittings and all the structural padding. No other material is welded directly to the heads or shell of the tank.

Even larger "T-1" Steel tanks are being built—over 10,000 gallons—for use in states where gross weight laws permit.

The very high yield strength of USS "T-1" Steel, coupled with its exceptional toughness down to very low atmospheric temperatures, and its ready weldability (normally without preheating or stress relieving) make it ideal for pressure vessels, tanks, standpipes and penstocks. Welded ½-inch-thick test vessels of this remarkable steel have withstood working stresses of as much as 136,000 psi without bursting—even when chilled to 50° below zero. And where code provisions do not apply, large "T-1" Steel vessels in service today operate at working stresses of 36,000 and 40,000 psi!

USS "T-1" Steel is available for immediate delivery. It might very well be the answer to your pressure problem. For complete information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
United States Steel Export Company

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sizes is sufficient to cover ¼, ⅜, and ½ in. to the foot. **Write or call: F. Ward Harman Associates, Halesite, Long Island, N. Y., for Model Component catalog.**

Throttling valve

. . . design features and specifications are presented in new four-page Bulletin SW-58. This bulletin gives the details on four throttling valves available in sizes from 2 to 20 in. Their ASA ratings range from 125 to 400 lb. Annotated line drawings and photographs show valve construction and operating features. **Write or call: Keystone Valve Corp., P. O. Box 6716, Houston 5, for Bulletin SW-58.**

Flow diagrams for ammonia synthesis

. . . from 10 different feed stocks are included in new Chemico Bulletin 357. Natural and refinery gas, light oils, LPG, residual and crude oil, hydrogen-rich byproduct gas, coke-oven gas, coal and coke, or water are detailed. Charts include processes for the preparation and purification of gas prior to entering the synthesis loop. **Write or call: Chemical Construction Corp., 1733 Commerce Building, Houston 2, for Bulletin 357.**

Automatic odorant-feed systems

. . . are detailed in new Data Sheet E-58-2, which illustrates and describes four automatic methods to meter and feed a precise ratio of odorant to natural-gas lines. The two-page data sheet explains how controlled-volume diaphragm pumps feed mercaptans or other odorants automatically and in accordance with varying main-line flow-rates—without leakage. Included are specifications, recommendations, flow diagrams, and lists of equipment used in each system. **Write or call: Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, for Data Sheet E-58-2.**

Canned-motor-pumps

. . . Bulletin 1050-3 is a four-page publication that details features and specifications of pumps for general process pumping. Included are performance curves for pumps up to 15 hp., dimensions, principles of construction and operation, cutaway views, materials available, and power requirements. The Series C Chempumps offer leakproof pumping of corrosive, toxic, radioactive, and other problem fluids at heads to 275 ft. and capacities to 600 g.p.m. **Write or call: Chempump Corp., 1300 East Mer-**

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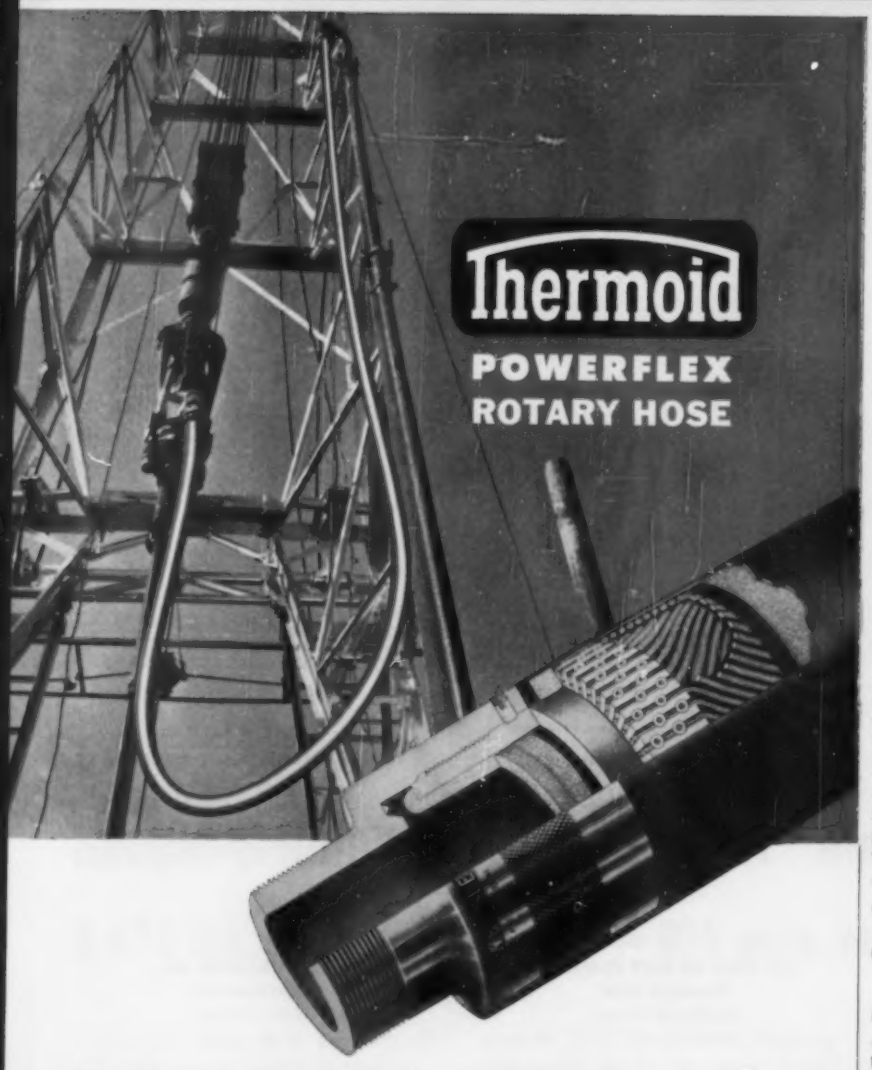

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maid Lane, Philadelphia 18, for Bulletin 1050-3.

Static-magnetic annunciator

. . . recently developed for monitoring complex automatic machine and continuous-process operations is described in new four-page Bulletin 101. The annunciator uses static-magnetic controls in place of conventional relays. They have no moving parts, resulting in an extremely high degree of reliability and reduced maintenance, the maker says. **Write or call: Panellit, Inc., 7401 North Hamlin Avenue, Skokie, Ill., for Bulletin 101.**

Ductile-iron pipe-lock couplings

. . . are described in new four-page Catalog PL-1. The catalog lists the specific cost-saving advantages of the K Series ductile-iron fittings and pressure ratings for various sizes as listed by Underwriters' Laboratories, Inc. It illustrates installation and recommendations for use. Price lists and size information for installing with Schedule 40 steel pipe are included. The fittings are available in two weights: 800-D (heavy) and 400-D (light). **Write or call: Kuhns Bros. Co., 1800 McCall Street, Dayton, Ohio, for Catalog PL-1.**

Motor-application guide

. . . is designed to make motor selection easy. Matching motor characteristics and load requirements has been simplified in the 12-page guide. An application chart provides information on typical driven equipment, character of loads, starting, and running torques. These factors have been matched to motor designs, motor types and descriptions, starting currents, speed ranges, horsepower ranges, and available enclosures. **Write or call: Century Electric Co., Eighteenth & Pine Streets, St. Louis 3, for motor-application guide.**

Armored rotameters

. . . designed for pressures up to 5,000 psi. and for flow-rate equivalents up to 3,000 g.p.m. of water are described in new eight-page Bulletin 130. Precision pressure-formed metering tubes dimensionally reproducible to the same high degree of accuracy as glass metering tubes are used in the new meters. They are trade-named Ar-Met rotameters. A guide to the selection of transmitting as well as point-of-measurement extensions for th rotameters is included. **Write or call: Brooks Rotameter Co., Landsdale, Pa., for Bulletin 130.**

J&L Supply Division assigns four salesmen

. . . reports W. L. Wolfe, vice president, sales.

C. J. Kriewitz, formerly located at the Denver office, transfers to Wichita Falls, Tex. R. J. Bevington previously assigned to Kilgore, Tex., shifts to Freer, Tex. L. C. Darnold, formerly assigned to the Kilgore store, has moved to the Longview, Tex., store but will continue as resident salesman at Kilgore. L. K. Meredith, previously at the Chase, Kans., store is assigned to the Great Bend, Kans., store but will continue to be resident salesman at Bushton, Kans.

Kriewitz began his service with J&L as a storeman at Casper, Wyo., in 1951 and was later transferred to Glendive, Mont., where he was store manager and later salesman. He moved to Denver in 1957 as salesman.

Bevington joined J&L as a storeman at Pleasanton, Tex., in 1949 and later transferred to Overton, Tex., where he was storeman, store manager, and salesman.

Darnold began his career with the division in 1950 as a salesman at Kilgore.

Meredith joined Atlas Supply Co. in 1936 at Muskogee, Okla. This company was purchased by J&L. He was later transferred to Russell, Kans., as store manager and then salesman.

Jack Douglas appointed sales representative

. . . of Lunkenheimer Co. of Cincinnati, Ohio. He has been assigned to the Dallas office where he succeeds E. R. Tieberman.

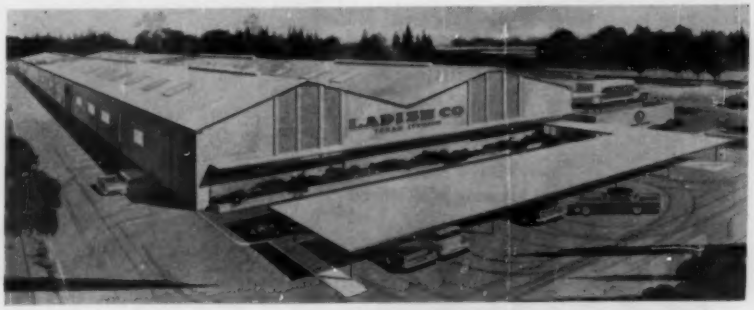
JACK DOUGLAS

Prior to joining the staff of the line valve manufacturer, he was with Supply of Des Moines, Iowa. Globe Machinery

R. T. Means promoted

. . . to the newly created position of supervisor of oil-field sales for Continental Oil Co.'s petrochemical department. Formerly a technical sales representative for Conoco, he will continue to make his headquarters in Midland, Tex.

He joined Conoco in Midland in 1956. Previously, he was for 8 years with Petrolite Corp., at St. Louis and New York City.



Ladish Co. opens new manufacturing plant,

. . . sales service office, and warehousing facilities which will operate as Ladish Co. Texas division. This plant, located in Houston, will serve the expanding needs of industries in Texas, the Gulf Coast area, Mid-Continent, and the Southwest with complete service in pipe fittings, corrosion resistant valves, saw blades, drop forgings, and rolled rings.

Caterpillar Tractor Co. boosts four executives

. . . according to President H. S. Eberhard. They are: Vice President Gail E. Spain to president of the foreign trade group; J. R. Munro, director of manufacturing for foreign operations, to vice president; and W. K. Cox, manager of sales promotion, to vice president. Succeeding Cox will be L. L. Morgan, who has been assistant manager of sales promotion since 1956.

G. E. SPAIN

J. R. MUNRO

In his new position, Spain will administer Caterpillar's British, Australian, Brazilian, and Canadian subsidiaries, as well as Caterpillar Americas Co., Caterpillar Overseas C.A., and Caterpillar of Delaware, Inc. He will continue as a vice president of the parent company. He has been with Caterpillar for 28 years and for the past 15 as vice president. He has been a vice president of the foreign trade group since its formation in 1956.

W. K. COX

L. L. MORGAN

Munro, who has devoted 40 years to all phases of Caterpillar manufacturing operations, will have administrative responsibility for its manufacturing division, including the functions of the manufacturing general office, purchasing general office, and traffic general office.

Cox succeeds Spain as vice president with administrative responsibility for domestic sales and sales promotion activities. He has been with Caterpillar 30 years, the past 5 of which he has been sales promotion manager.

Morgan has been with the company 12 years, serving in both its domestic sales and sales promotion departments.

The National Supply Co. names Jack K. Sutter

. . . as manager of tubular sales. He succeeds Charles J. Ramsburg, Jr.

J. K. SUTTER

Sutter joined the Spang-Chalfant division of National Supply in 1927 and later served in the New York, Memphis, and Boston sales office. He became Pittsburgh district manager in 1950 and has been sales manager, standard pipe products, since 1956.

BS&B, Inc., appoints

. . . Hudson Engineering Co. of Birmingham, Ala., and North-Monsen Co. of Salt Lake City, Utah, as manufacturers' representatives for its controls, safety heads, and tank vents,

according to Henry A. Ruysser, executive vice president of Black, Sivalls & Bryson.

Andre Blanchard named vice president, technique

. . . by the directors of Schlumberger Well Surveying Corp. In his new position he will be in charge of the entire research and engineering program. Since joining Schlumberger in 1943, he has been head of the engineering department. He was elected vice president, engineering, in 1951.

Chicago Pneumatic Tool Co. forms arrangement

. . . for marketing and distribution with Ken W. Davis of Fort Worth, Tex., president of Harrisburg Sales & Service, Inc., according to Guy J. Coffey, president of Chicago Pneumatic.

The world-wide marketing and distribution of Chicago Pneumatic oilfield products will be handled by a new Texas corporation formed by Davis called CP-Harrisburg, Inc. Coffey stated that the new company is not a subsidiary of Chicago Pneumatic nor of Mid-Continent Supply Co., of which Davis is also president.

Chicago Pneumatic has manufactured drilling bits and other oil-field equipment for over 28 years. Harrisburg Sales & Service has been supplying the oil industry with diamond hard products through authorized supply companies since 1930. The new company will operate independently to promote world-wide sales of these products.

Coffey and Davis announce the formation of CP-Harrisburg, Inc.

Grant Oil Tool Co. Permian basin sales staff

. . . assembled in Odessa for their quarterly meeting are, standing: Raymond Taylor, Samuel Gleaton, Drew Johnson, Glenn Hunt, Luther Pirtle, Hobbs Branch Manager Robert Melton, and Field Engineer Ken Shellman. Seated are: Carl Williams, Division Manager Rex Walling, Vice President Albert Salvatori, Reater Mead, and Russell Gifford.

They were informed of the recent acquisition of the Zublin line of drilling tools, including the differential and simplex bits and the Director Corp.'s line, including the Fluidrill hydraulic drill collar. They also learned of Grant's new developments, the Spiro-Jet desander, the impact valve seat puller, and the combination hydraulic valve seat and piston pullers.

W. Doss Lumpkin named senior sales engineer

W. D. LUMPKIN

. . . by Dr. R. E. Reitmeier, president of Catalysts & Chemicals, Inc. In his new assignment Lumpkin will specialize in the sale and application of catalysts for the hydrotreating of refinery feed stocks in the petroleum industry. He will also handle hydrogenation and hydrogen-manufacturing catalysts used in the edible and inedible fats and oils fields.

He began his career with Phillips Petroleum Co. at the Okmulgee, Okla., refinery. Later he joined the sales staff of Filtrol Corp. of California. More recently, he has held positions at Girdler Co. at a sales engineer.

Tubular Lining Corp. assigns C. J. McBride

C. J. McBRIDE

. . . as sales manager for the East Texas-Northern Louisiana area, according to Larry E. Heinen, president. McBride will head quarter in Shreveport, La.

He was formerly TLC's director of research and development department. He has been with the company since its founding, 2½ years ago.

Otis Engineering Corp. names Dick M. Koons

D. M. KOONS

. . . director of research and development. He joined Otis in February of this year as a development engineer.

He was with Cia. Shell de Venezuela in Maracaibo for the past 13 years as senior production engineer. Prior to this, he was with Geologic Standards and The Texas Company, both in Tulsa. He is assuming the duties of Harry B. Schramm, former vice president of research and development.

McCullough Tool Co. reports personnel changes

. . . in its eastern division operations, according to O. J. McCullough, vice president.

Branch Manager James Luther, formerly manager of its Natchez, Miss., service branch, has transferred to Harvey, La., in the same capacity. Herbert D. Whisman, former sales representative in the Natchez area, has been named branch manager at Natchez, replacing Luther.

F. E. Epperson, branch manager, has shifted to New Iberia, La., from Healdton, Okla.; C. M. Ambrose, former sales representative in the Natchez area, moved to Laurel, Miss., and elevated to the position of branch manager. Jack W. Gardner was appointed branch manager at the Snyder, Tex., service branch. He

formerly served as sales representative at Medicine Lodge, Kans.

Roy Neal Collum, sales representative, formerly in the Tulsa sales office, transferred to Shreveport, La.; Marshall C. Gaugh has been shifted from Shreveport to Natchez, and becomes sales representative in that area. Sales representative Cholly Howard has been transferred to Odessa, Tex., from San Angelo, Tex.

C. C. Randall appointed sales representative

C. C. RANDALL

. . . to cover the Houston area for Atlas Pipe, Inc., announces W. H. Becker, president.

Randall has approximately 7 years' experience in the sale of tubular goods in Houston, having represented National Tube Co. from 1945 to 1952 as a salesman of standard pipe. Just preceding his association with Atlas Pipe, he was for 5 years one of the owners of Barge Service Corp.

Tubular Lining Corp. shifts Robert Bryson

ROBERT BRYSON

. . . to Lafayette, La., as manager of the company's sales office there. He will cover all of southern Louisiana from his new location.

The move is based on a plan broadening services for major sales areas, according to Larry E. Heinen, president of the Houston applicator and compounder of plastic linings for oil-field tubing.

Bryson has completed TLC's college training program which includes a thorough apprenticeship in production sales, administrative, and office procedures. Since then he has been working out of the Houston office.

Prior to joining TLC, he was employed in a production capacity in the textile industry.

John R. Mueller appointed

. . . as service manager of the Witte Engine Works of Oil Well Supply Division, U. S. Steel Corp., according to K. O. Nilsson, Witte general manager.

Mueller was employed in 1946 at the Kansas City plant as a service engineer. He became field engineer in 1950 and sales representative in 1954. Prior to his present appointment, he was Witte's railroad service representative.

Massey-Ferguson Industrial Division promotes Talmage

BILL TALMAGE

. . . to the position of general industrial sales manager, reports C. J. Davis, general manager of the division.

Bill Talmage, formerly central regional industrial sales manager for Massey - Ferguson, has 20 years' experience in sales.

Earlier he spent 6 years with Tractor Sales Corp., Los Angeles Ferguson distributor. He covered a Ferguson zone and was branch manager of its general line distribution in Stockton, Calif. Previously he was industrial representative for J. I. Case Co., for California, Arizona, Nevada.

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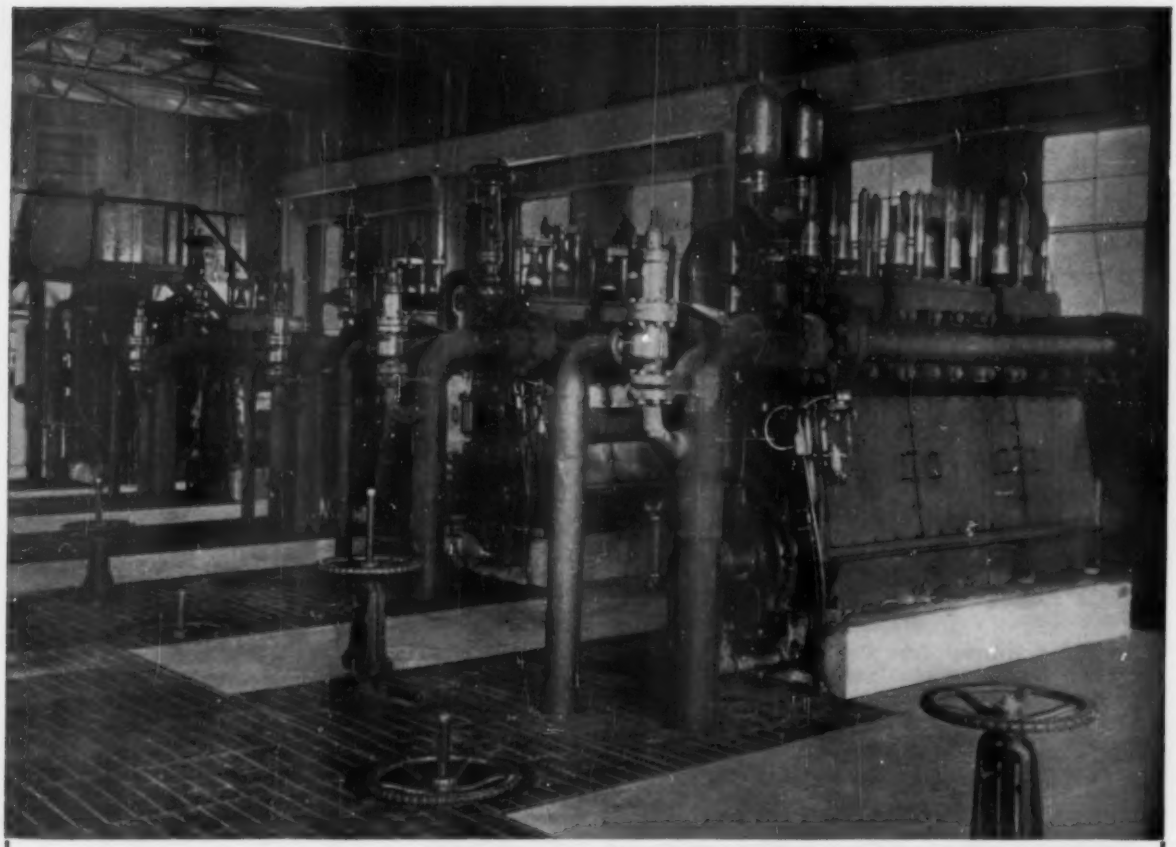

FIELD REPORT

FLOOD: Salem Unit

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EXPERIENCE TO DATE:

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Field parts stock available in Carmi, Ill.; Charleston, W. Va.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the Aldrich Pump Company, 9 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

"Nothing settles dust better than oil"

BY FRANK J. GARDNER

AFTER 50 years of constant oil and gas activity, Oklahoma will probably write more oil history in 1958 than any other state in the oil column.

Three wildcats . . . No area is busier and none is making headlines quite as consistently as western Oklahoma. During the last 2 weeks, three isolated wildcats have taken turns at shoving each other off the front page.

It's hard to say which of these is the most important, for each has a distinction of its own. But probably the one with the most impact is the Sinclair Oil & Gas Co. 1 Holcomb, Section 7-28n-22w in Harper County.

Why is it important? Well, because it found six potential pay zones on the way down. Or because it was Sinclair's fifth consecutive wildcat strike in Oklahoma this year. Or (the clincher) because it has opened the Arbuckle-Ordovician formation to extensive future exploration throughout a vast area of western Kansas as well as western Oklahoma.

The 1 Holcomb lies 40 miles southwest of the nearest other Arbuckle production at Yellowstone field, Woods County. On the way down, it had multiple showings, mostly gas, in the Lovell, Kansas City, Marmaton (all Pennsylvanian), the Mississippian, and in the Viola-Ordovician, but it was the Arbuckle flow that made the headlines. On test of the interval 7,664-7,717 ft., the flow was 400 bbl. in 14 hours (13/64-in. choke) of 48.5° oil.

In the Anadarko . . . Now look at the map. You will see only widely scattered Arbuckle fields in this, the Anadarko basin. To the north lies Grigston pool, discovered in Scott County, Kansas, in December 1954. This is the first and so far the only Arbuckle field in all of western Kansas. It has seen only three completed wells. Forty miles northeast of the Sinclair discovery lies Yellowstone, where 12 Arbuckle wells have been finished since discovery of the field in 1953. Far to the southwest in the Texas Panhandle's Gray County is the Laketon-Ellenburger oil field, a 1955 strike. And that completes the Arbuckle picture in this vast region.

THREE REMOTE WILDCATS are making exploration history in Oklahoma's Anadarko basin. All are "firsts" in one way or another: the first Arbuckle producer in western Oklahoma, the first field in Custer County, and the first oil field in Blaine County.

Southeast of the Sinclair discovery lie two other highly significant drillers. In Custer County, Magnolia Petroleum Co. 1 Miller, Section 22-15n-16w, has had commercial flows of gas and condensate on a drill-stem test of the Springer - Pennsylvanian sand in an open-hole section at 11,490-11,604 ft. If completed as a successful well, Oklahoma will have an entirely new productive county.

Northeast of the Custer County well, Miles Jackson Drilling Co. 1 Haigler, Section 26-18n-13w, is making discovery history in Blaine County. On a drill-stem test of the Morrow-Pennsylvanian at 8,610-8,750 ft. this one recovered 2,228 ft. of 42° oil and is now drilling ahead on a 9,000-ft. contract. The nearest oil field is 20 miles to the northeast at Ringwood, a Mississippian producer. And the nearest gas field is 12 miles northeast at Northwest O'Keene field. This promises to be a candidate for "discovery of the year" along with the Sinclair 1 Holcomb, and both are opening new fields in new places from old formations long known for their productivity. This will be Blaine County's first oil field.*

Redeem an infamous bowl . . . So put a big blue flag on your western Oklahoma map. Here's the first-prize winner in oil and gas exploration for 1958. And the year is only half over. Here is the infamous dust bowl of the great depression. Here is the scene of "The Grapes of Wrath." And those who walked away from it could hardly be blamed at the time. But in the next 2 years there will be a great many more people walking into it than ever walked out of it. Nothing settles the dust better than oil.

*We think perhaps we have made progress in oil exploration. But have we? It has taken 30 years for the following words to filter through to the discovery thinkers of western Oklahoma:

"The country is overrun with geologists, lease men, and royalty buyers now. New developments in Blaine County, with virtually every major oil company in Oklahoma buying acreage, are said to be the forerunner of the opening of a new producing area . . .

"Over 100 geologists are in the county, and it has been established that more known structures exist in Blaine than in any other western county . . ."

—From The Daily Oklahoman, April 15, 1928.

Research reveals the part carbon compounds played in

The primitive earth

BY BARTHOLOMEW NAGY
Fordham University

FOR SEVERAL YEARS, Dr. Bartholomew Nagy, now assistant professor of chemistry at Fordham University, has conducted basic research studies in the field of geochemistry. It is his belief that a better understanding of the subject may eventually lead to its widespread practical application in the search for oil and gas. Because of the increasing interest in geochemistry and its possibilities as a future oil-finding method, the Journal is presenting Dr. Nagy's work in five installments, to appear biweekly during July and August.

In this first installment, the author outlines the organic geochemistry of early geologic time, and describes some experiments in that field. Dr. Nagy, before joining Fordham, was with Cities Service Research & Development Co.

FUNDAMENTAL chemical research has recently led to the discovery of interesting data regarding the role of various carbon compounds in geological processes. To be of maximum value to the geological sciences this information needs to be summarized and presented, if possible, in the form of a coherent picture.

Such an attempt is also encouraged by the recurrent interest in applied geochemical investigations, such as soil-analysis surveys. These applications will undoubtedly take less effort and lead to reliable results much quicker if they are based solidly on the fundamentals of carbon-compound geochemistry.

One of the purposes of this article is to emphasize that the field of carbon-compound geochemistry includes several subjects other than soil-analysis surveys. The various chemical processes involving carbon compounds in sedimentation, in the soils and in bodies of water and also in the atmosphere are all of interest to organic geochemistry.

Certain aspects of the chemistry of organic mineral deposits (coal and petroleum), which are the greatest accumulation of organic compounds in nature, will be discussed, following a review of subjects of basic background.

The discussion of the following subjects paves the way to the discussion of the geochemistry of petroleum and coal deposits:

- Evolution of organic compounds in the primitive earth.
- Modern principles of the development of sedimentary rocks.
- The effect of climatic variations on the development of sedimentary rocks and of organic deposits.
- The physics and chemistry of the sedimentary basin (for the sake of brevity the "lake-system" will be discussed).
- The microbial chemistry of soils —the port of entry of the majority of organic matter into the realm of geology.

Following a discussion of the geochemistry of petroleum deposits, an experiment will be described, performed at Fordham University, which led to the cosynthesis of micaceous minerals and organic substances from inorganic salts, water, and soil-type waxes in pressure vessels under physical-chemical conditions which were similar to those present in the sediments after deposition.

The last chapter will summarize the application of selected geochemical and sedimentary petrological principles to a generalized, practical problem of petroleum exploration.

Early Geologic Times

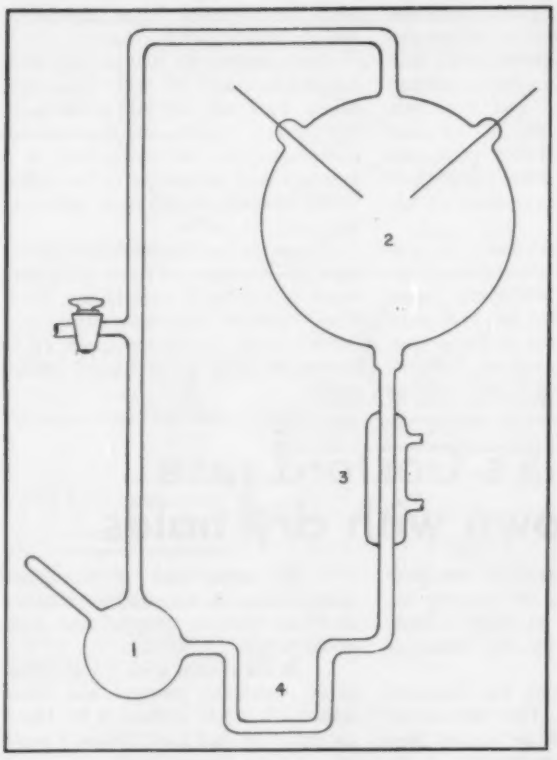
From the very earliest history of the earth, carbon compounds have played an important and sometimes even decisive role in geological events. Some of the most interesting experiments and deductive reasoning of the past few years centered around formation of organic compounds in the primitive earth.

Studies of stellar spectra, a more complete understanding of the abundances of the elements in the universe, analyses of gases in meteorites and in current volcanic effluvia, thermodynamic calculations, etc., permit us now to propose an atmosphere and hydrosphere for the primitive earth with at least some degree of certainty.

Interstellar dust particles including iron and silicon compounds, floating in noncondensable gases of hydrogen and helium have aggregated into what became the primitive earth, possibly by a process of turbulent gas currents induced by light pressures from surrounding stars, as proposed by Weitzsacker (1944).

After a certain period of time the surface temperature of the new planet started to decrease, the crust formed, and the primitive oceans developed. The chemical composition of the earth's first air and water envelopes, that is the primitive atmosphere and hydrosphere, is still the subject of disagreement among various authorities. However, information now available also makes them agree on some significant points.

The most central point of agreement is the presence of water in the primitive atmosphere and hydrosphere, together with the presence of carbon and nitrogen compounds. Urey (1952) suggested that carbon was



GASEOUS mixture is heated in container (1) to promote circulation; the reaction takes place in flask (2) with aid of electrical discharges; reaction products are cooled (3), and collected in trap (4). Fig. 1.

present in the form of methane, whereas others favor carbon dioxide or carbon monoxide. Nitrogen is believed to have been present either in the form of ammonia or in the form of N_2.

The major disagreement centers around the question of whether the primitive atmosphere was reducing or oxidizing in nature, a considerable difference in respect to impending chemical evolution. Fox (1957) suggests a compromise by stating: "If one considers the primitive atmosphere as nonoxidizing or oxidized, rather than reducing or oxidizing, the disagreement in outlook is considerably dulled, and the evaluations are probably more sharply stated." The primitive envelopes suggested by various authors for the planet earth are the following:

Author—	Primitive envelope
Rubey (1955)	Atmosphere: CO_2, N_2, H_2S, H_2O Hydrosphere: CO_2, NH_3, H_2S, H_2O
Bernal (1951)	Atmosphere: $CH_4 \rightarrow CO_2$, $NH_3 \rightarrow N_2$, H_2O, H_2 Hydrosphere: CO_2, NH_3, N_2S, H_2O
Oparin (1953), Urey (1952)	Atmosphere: CH_4, NH_3, H_2O, H_2
Revelle (1955)	Atmosphere: CO, CO_2, N_2, H_2S, H_2O

Although some authors excluded hydrogen sulfide, its presence may be necessary to explain certain biochemical reactions which followed the synthesis of primitive chemical compounds.

Another line of thought, currently prevalent among geologists, states that the primitive atmosphere of the earth was lost during early geological times and was consequently replaced by gases escaping from the interior of the earth. These gases appear to have been similar, however, in composition to the suggested primitive envelopes, H_2O, CO, CO_2, etc., so this variation in thought is not basically contradictory.

Recent developments in chemistry, physics, and astrophysics had a pronounced effect on research dealing with the chemical evolutions of early geological times. They added a scientific foundation to mere speculations to the extent that this branch of investigations became a "respectable" line of scientific endeavor attracting some of the most authoritative scientific personnel.

The experiment performed by Miller (1953), (1955), following the suggestion of Urey, resulted in the synthesis of amino acids in a simulated, primitive atmosphere with the aid of electrical discharges. Amino acids are, of course, one of the basic chemical building blocks of animal and vegetable matter. Their molecular structure is:

$$\begin{array}{l} R\ CHCOO— \\ \quad\ | \\ \quad NH_3+ \end{array}$$

Individual amino acids joined together by peptide linkages form the various proteins.

The Miller experiment . . . Because Miller's study had a stimulative effect on organic geochemistry research concerned with the early geologic times, it may be well to briefly outline his experiment.

He artificially prepared a gas mixture of CH_4, NH_3, H_2O, and H_2, such as suggested by Urey for the primitive atmosphere, and allowed this mixture to circulate in the simple, closed, glass apparatus shown in Fig. 1. The gas mixture was passed through a continuous electrical discharge, then cooled in a Liebig condenser.

The reaction products were collected in a trap. After several days, detectable amounts of reaction products were isolated and analyzed. Paper chromatographic analysis revealed the presence of the amino acids, glycine, alanine, aspartic acid and α-aminobutyric acid. The amino acids were optically inactive.

It is interesting to note that the compounds which were obtained in this experiment also participate in the synthesis of the protein structures of all living organisms. Methane was the source of carbon in Miller's gas-sparking experiment. However, Abelson (1956) reported that various mixtures of gases containing CO_2 and water also yield amino acids in sparking experiments. This suggests that amino acids could have probably been formed in any of the various proposed primitive atmospheres by suitable electrical discharges.

These data led to speculations. It has been suggested that electrical discharges in the form of lightning produced amino acids in the primitive atmosphere, the reaction products condensed into the early oceans where they formed dilute solutions. It is likely, however, that they would have been decomposed rapidly, especially if the atmosphere was oxidizing. If the accumulation of these biochemical compounds was faster than their decomposition, one may visualize a mechanism which might have paved the way to further synthetic reactions.

Knowing that lightning action in the earth's primitive atmosphere can lead to amino acid synthesis (and that it is not difficult to justify the development of thunderstorms and lightning in the primitive atmosphere), natural-

ly, the next step of inquiry is the examination of the possibility of the development of protein structures. This involves finding a mechanism which may lead to the joining of individual amino acids through peptide bonds.

The structures of biochemically eminent macromolecules such as proteins, nucleic acid and polysaccharides reveal that these molecules are formed by the loss of water. Application of thermal energy helps to overcome the energy barrier to peptide bond synthesis through the process of water removal. Peptide synthesis may therefore be attempted, as suggested by Huffman (1942), by the use of elevated temperatures. Again, it is not difficult to justify elevated temperatures on the surface of the primitive earth, particularly shortly after the crust had first crystallized.

The Fox-Middlebrook tests . . . Fox and Middlebrook (1954) performed such thermal experiments with amino acids in the laboratory. Although they reported preliminary indications of peptide formation their experimentation lead to a different, but equally important path. The experiments revealed that thermal treatment of amino acids leads to the formation of additional amino acids. For example, the heating of aspartic acid (which was also synthesized in Miller's experiment) resulted in the formation of α-alanine and β-alanine, and other amino acids.

Fox and his associates subjected their samples to temperatures up to 200° C. They report that in contrast to the belief that the heating of most of the amino acids leads to tars and other decomposition products, the heating of amino acids which alone do not form linear peptides do so when copolymerized with one of the few amino acids (such as aspartic acid, glycine) which have been recognized as probably forming linear peptides alone.

Perhaps even more significant are their thermal experiments with malic acid, fumaric acid and urea. Thermal treatment of these substances resulted not only in the formation of amino acids, but also in the synthesis of various other compounds such as vitamin and nucleic acid intermediates. This chemical process, Fox (1957) remarks, is closely paralleled to those of known biosynthetic pathways.

If one can account for the presence of malic acid and urea in the primitive oceans or atmosphere, perhaps as intermediates in the amino acid synthesis, then the chemical development sequence observed by Fox in the laboratory, certainly looks attractive.

One may add that urea can be synthesized in a closed system from ammonia and carbon dioxide at approximately 130° C. temperature. In Miller's sparking experiments of ammonia, methane, water and hydrogen, carbon dioxide was one of the reaction products, and Rubey postulated the presence of both ammonia and carbon dioxide in the primitive hydrosphere.

The role of thermal energy in promoting biochemical development has also been observed elsewhere. Copeland (1936) found that the blue-green algae species which live in the thermal waters of the Yellowstone National Park may be regarded as the ancestral form of ordinary algae commonly found in lakes and marshes.

These studies do not yet tell what has taken place in early geological times. They only tell that amino acids and other significant biochemical compounds can be synthesized in a system which is thought to be similar to the atmosphere and hydrosphere of the primitive earth.

A rigorous evaluation of the organic chemical reactions of early geological times is a difficult undertaking. However, careful experimentation and measurement of data may open up an interesting field of geological knowledge.

California's Gosford race slows down with dry holes

FOLLOWING a series of excellent offsets and stepouts, the recently active Gosford field in Kern County was slowed down by two abandonments.

The most significant was Hancock Oil Co. 11-13 KCL. This wildcat was originally completed as a new pool discovery 1 mile northwest of the Gosford area in April. Initially it was making 100 lb. daily. Production rapidly fell off until Hancock plugged and abandoned it. It was completed in a zone at 7,353-57 ft. Total depth was 10,405 ft.

The other abandonment in the area was a 10,832-ft. wildcat drilled by Union Oil Co. about 1¼ miles due west of the Gosford activity. Union decided to pull out after running electric logs, dipmeter and sidewall samples on the test.

Elsewhere in the field, these projects were active:

. . . Hancock was preparing to run tubing in 14-13 KCL, a well drilled to 9,730 ft. about three locations south of their abandoned 11-13 KCL north of the main area of the field.

. . . Getty Oil Co., Superior Oil Co., Union and Universal Consolidated Oil Co. had tests in various stages of drilling in the main area of activity.

Universal Consolidated, discoverer of the recent area of development last October has eight wells in the pool.

Dry holes elsewhere . . . Gosford wasn't the only area plagued with dry holes. Elsewhere in the state, these wildcats failed to turn up anything and were abandoned:

. . . In the Belgian Anticline field, Shell Oil Co. abandoned a shallow test at 1,720 ft. on a location more than 1 mile west of the nearest production in the northwest area of the field.

. . . Six miles east of Kettleman South Dome in Kings County, Gilles de Flon, operator, plugged and abandoned a 1,350-ft. wildcat.

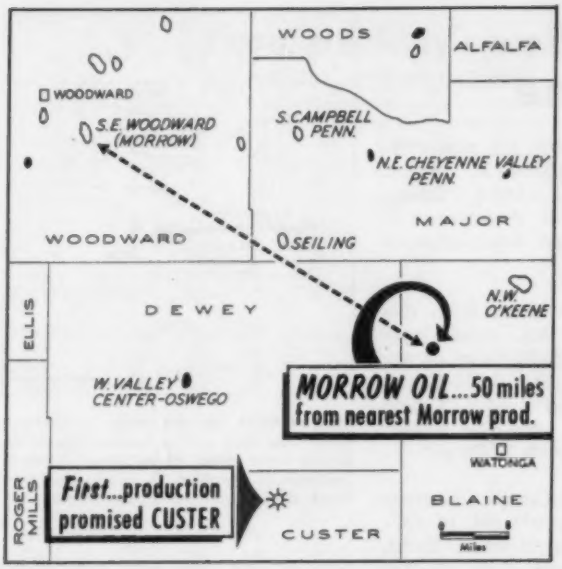
. . . In the coastal area, Verde Enterprises, operator, plugged and abandoned a 7,753-ft. wildcat in the Huasna region of San Luis Obispo County inland from Pismo Beach.

California highlights . . . Union Oil Co. announced plans to drill its third test of its 2,500-acre townlot block it put together several years ago in Bakersfield. Objective will be the Stevens zone, highly productive in areas adjacent to Union's planned next test in northwest Bakersfield . . . Richfield Oil Corp. first offset to its Highway area pool discovery in the North Tejon field looks good. On a formation test of a Vedder interval at 11,500-11,663 ft., the well reportedly flowed at a rate of 3,000 bbl. daily through a ½-in. choke. This is a southerly offset to Richfield's discovery . . . Blu-Cal Oil and Gas Corp. completed a 944-ft. wildcat in the Petaluma region of Sonoma County in northern California as a shallow gas-pool discovery. It was reported making 300 M.c.f. daily through a ¼-in. choke . . . Shell Oil Co. was grading a location for a wildcat ¾ of a mile south of Pleito Ranch field and the same distance east of Pleito Creek field in southern Kern County.

OREGON

Oregon's Prineville test drilling

Sunray Mid-Continent Oil Co. was drilling ahead below 4,772 ft. on its wildcat in the southeast Prineville region of Crook County.



MORROW SAND oil production is promised at a remote wildcat in Blaine County, northwestern Oklahoma, jumping the Woodward trend 50 miles to the southeast.

AN upper Morrow-Pennsylvanian gas discovery was completed in northwestern Texas County, Oklahoma Panhandle. The new field-opener is Petroleum, Inc. 1 Denning, C SE NW 30-6n-11eCM, northeast of Carthage gas field. The well flowed 8,100 M.c.f. of gas per day from the upper Morrow at 4,518-28 ft. The west offset to this strike is the 1 Horner in NE NE SW 25-6n-10eCM. It is a possible Morrow oil discovery. The operator has landed casing.

Woodward trend leaps

MORROW - PENNSYLVANIAN oil production is indicated at Miles Jackson Drilling Co. 1 Haigler, C SW SE 26-18n-13w, 13 miles northwest of Watonga in Blaine County, northwestern Oklahoma. Successful completion of this important wildcat would add a 50-mile link to Oklahoma's so-called Woodward-Morrow trend.

A drill-stem test at 8,610-8,750 ft. recovered 2,228 ft. of 42°-gravity oil. Nearest oil production is 20 miles northeast at Ringwood; nearest gas production 12 miles northeast of Okeene. There are several Pennsylvanian fields in the region—one at West Valley Center to the west in Dewey County, two in Major County to the north, and the Morrow fields of Woodward County to the northwest.

First Custer production . . . One of the three remaining counties without oil or gas production in western Oklahoma appears headed for a gas-distillate discovery.

Magnolia Petroleum Co. tested the Springer-Pennsylvanian sand at its 1 Boyd Miller in C SE NW 22-15n-16w. The well flowed 1,250 M.c.f. of gas per day from open hole at 11,490 to 11,604 ft. with an estimated 24 bbl. of distillate per million. If successful, this wildcat would open first production in the county, would move Springer production into its remotest position in the Anadarko basin, and could easily throw open the door to an active drilling campaign in this section.

The Sooner State keeps busy

THE WEST FLANK of northern Oklahoma's Nemaha granite ridge picked up a Mississippi chat oil discovery last week. Riverside Oil Co. opened a new producing zone in South Breman field, Kay County, at its 1 Morrill, SW NW NE 31-28n-1w, west of the Cleveland sand production in the field.

The well flowed 309 bbl. of oil per day on ¼-in. choke from 100 ft. of net pay sand in an estimated 400-ft. section of chat at 3,715-31 ft. Bottomhole pressure was 1,430 psi.; shut-in pressure was 1,300 psi. Gravity is 37°.

The discovery will be called a new pay for South Breman. Location is on the downthrown side of the faulted west side of the Nemaha granite ridge, a regional feature that begins at the Oklahoma City uplift, running northeast through Kansas to the Forest City basin in southeastern Nebraska.

Beaver County gets Dombey area strike

Beaver County in Oklahoma's Panhandle section has a new Chester-Mississippian gas discovery.

The Texas Co. 1 Ratslaff, C NW SE 5-3n-21eCM, flowed 2,310 M.c.f. of gas per day from perforations in the Chester at 6,659-63 and 6,667-73 ft.

Location of this new pool is just southeast of Dombey oil pool in the west-central portion of the county.

Love County area adds to production

Southeast Marietta field, new Love County discovery area in southern Oklahoma, is growing. Pasotex Petroleum Co. 1 J. C. Brannan, NW NE NW 30-7s-3e, northwest of the field discovery well, flowed gas at the daily rate of 20 M.M.c.f. and 91 bbl. of distillate per million from the Oil Creek-Ordovician at 13,940-14,032 ft.

Triple completions not unusual, but

West Texas gets big one

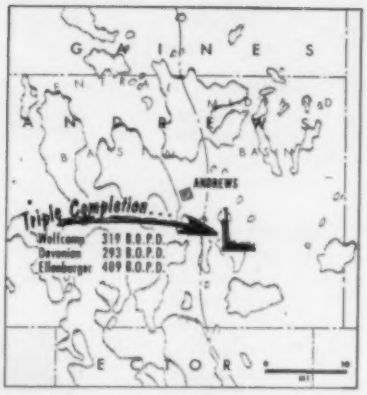
TRIPLE COMPLETION—producing simultaneously from three separate zones—is not news any more, nor is it an everyday occurrence. In West Texas its main significance is in the number of pay formations operators have to shoot at.

Last week David & Inez Fasken 2-J Fee, about 10 miles southeast of Andrews, in Andrews County, was completed from the Wolfcamp, Devonian, and Ellenburger formations. As a Wolfcamp and Ellenburger producer it was assigned to the Fasken multipay field, and to the South Andrews field for its Devonian production. Location is in Section 5, Block 42, Township 2 North, G&MMB&A Survey. Potentials on its three producing zones follow:

Wolfcamp . . . Daily potential was 319 bbl. of 44°-gravity oil, plus 40% water, through 20/64-in. choke. Gas-oil ratio was 1,586:1. Tubing pressure was 750 psi. Perforations at 8,436-8,672 ft. had been acidized with 2,500 gal.

Devonian . . . Potential from this formation was 293 bbl. of 46°-gravity oil a day, through 20/64-in. choke, from perforations at 10,930-11,032 ft. Gas-oil ratio was 1,768:1. Tubing pressure was 258 psi. The section had been acidized with 2,500 gal.

Ellenburger . . . Completion from this formation was 409 bbl. of 52°-gravity oil through 13/64-in. choke, giving the well a total daily potential of 1,021 bbl. Ellenburger perforations were between 12,583-12,623 ft. and completion was without acid. Tubing pressure was 840 psi., with gas-oil ratio of 612:1. Total depth of the well was 12,634 ft. Parker Drilling Co. had contract.



RIG SYMBOL on the map is Fasken's three-pay well in the Fasken-South Andrews field area of Andrews County. Geological location is along the east flank of Central basin platform.

Canadian success lags, but new developments expected

ALTHOUGH exploratory drilling operations in western Canada during the past few weeks have failed to turn up anything "big" a few minor finds have resulted and one of those could be the forerunner of a sizable development.

That single test was drilled by Anglo Pacific Gas & Oil, Ltd., independent Canadian oil firm, in the Vauxhall district of southeastern Alberta. Drill-stem test in the Sawtooth member of the Ellis group gave up 240 ft. of light-gravity crude oil and subsequent tests were reported to have indicated a 126-ft. section of water-free limestone.

Coupled with that find to make the past week one of the most promising in the last month, was a Canadian Pacific Oil & Gas Co. success in the Makepeace-Chancellor region (the firm's initial success since forming the oil and gas department of the Canadian Pacific Railway), a Canadian Husky Oil Co. find in the general Bellshill Lake-Thompson Lake district of Alberta, and a Canadian Devonian Oil Co. strike near Alameda in southeastern Saskatchewan.

Vauxhall . . . Little is known about the Anglo Pacific strike, but officials of that firm stated that of the 126-ft. limestone section present, 96 ft. of it is considered to contain intermittent light-green high-gravity oil. The well, 7-10-14-15 Vauxhall on LSD 7, 10-14-15w4, lies 8 miles northeast of Vauxhall townsite, 6 miles northwest of the closest previous test in the region, and 11 miles northwest of oil and gas production in the Hays region.

Many other ventures in the general area of this strike have found the Ellis oil bearing but this is the first to have a sizable pay section. Apparently the porous sector is being fed by vertical fractures from the Madison. In addition to Anglo Pacific, Commercial Minerals, Ltd., New Continental Oil Co., Precision Radiation Surveys and Aldina Leduc Oils also have interests.

Makepeace . . . The Canadian Pacific Railway's subsidiary, Canadian Pacific Oil & Gas Co., recently started developing on its own a portion of the 8,500,000 acres held by it in Alberta. The first two starts, one in the Gem region and one near Rolling Hills near gas production. Both were abandoned, while the latest in the Makepeace district gassed at apparent commercial volume from the basal Colorado zone.

This venture, C.P.O.G. 10-14-23-19 Makepeace on LSD 10, 14-23-19w4, is 2½ miles southeast of the T.G.T.-Mobil-C.P.R. 21-1 Makepeace basal Colorado gas success and 65 miles east of Calgary.

Drill-stem test of a 35-ft. zone below 3,850 ft. gave up a maximum flow rate of 4,200 M.c.f. daily. There was no water in the pipe recovery. Drilling is again proceeding on the test which is scheduled for completion around the 4,500-ft. level.

Thompson Lake . . . The Canadian Husky venture that discovered gas in the general Thompson Lake oil region, 4-35-40-10 Choice on LSD 4, 35-40-10w4 was drilled in conjunction with Phillips Petroleum Co., Permo Oil

Here are May's well completions in U. S.

	TOTAL COMPLETIONS							WILDCAT WELLS							
	Total	Crude	Cond.	Gas	Dry	Service	Footage	Total	Crude	Cond.	Gas	Dry	Footage	C.T.	Act. op.
Alabama	6	6	0	0	0	0	69,022	0	0	0	0	0	0	0	13
Arizona	3	0	0	0	3	0	11,176	3	0	0	0	3	11,176	0	6
Arkansas	56	23	0	2	31	0	202,565	22	2	0	1	19	97,912	0	73
California	140	85	0	8	47	0	579,057	39	3	0	1	35	165,816	1	121
Colorado	74	20	0	5	49	0	399,990	41	5	0	1	35	224,866	2	87
Illinois	199	75	0	5	119	0	450,194	38	1	0	0	37	74,179	15	363
Indiana	66	20	0	1	43	2	101,610	29	0	0	0	29	42,972	50	79
Kansas	363	148	1	25	172	17	1,291,724	80	10	0	4	66	299,418	9	340
Kentucky	97	35	0	21	41	0	160,457	11	2	0	0	9	18,520	70	117
Louisiana	310	144	34	10	121	1	2,570,302	54	3	5	2	44	490,489	0	374
North	95	42	0	9	44	0	351,813	19	1	0	1	17	117,473	0	119
South	165	75	27	1	61	1	1,729,059	28	0	3	1	24	292,399	0	206
Offshore	50	27	7	0	16	0	489,430	7	2	2	0	3	80,617	0	49
Michigan	32	15	0	2	15	0	99,453	9	1	0	0	8	27,056	21	101
Mississippi	26	11	1	0	14	0	234,442	15	2	1	0	12	138,007	0	40
Missouri	1	0	0	1	0	0	383	1	0	0	1	0	383	1	2
Montana	27	13	0	0	14	0	149,013	10	0	0	0	10	39,465	6	54
Nebraska	64	16	0	0	48	0	370,898	29	2	0	0	27	173,382	0	33
New Mexico	134	79	1	28	26	0	632,086	18	3	0	0	15	97,746	28	234
West	54	15	0	27	12	0	233,029	8	1	0	0	7	33,385	0	130
East	80	64	1	1	14	0	399,057	10	2	0	0	8	64,361	28	104
New York	43	21	0	1	1	20	61,076	1	0	0	0	1	4,231	43	21
North Dakota	42	24	0	0	18	0	283,846	14	3	0	0	11	93,624	0	48
Ohio	91	45	0	22	15	9	228,557	2	0	0	1	1	8,790	90	191
Oklahoma	609	304	10	29	244	22	1,897,471	88	8	4	2	74	349,577	187	813
Tennessee	3	0	0	1	2	0	2,650	3	0	0	1	2	2,650	3	4
Texas	1,643	884	71	67	597	24	7,332,531	338	38	9	6	285	1,806,943	83	957
District 1	102	37	2	4	59	0	264,963	54	3	0	2	49	128,357	12	28
District 2	84	25	12	15	31	1	510,668	25	4	3	1	17	173,980	0	28
District 3	134	52	11	5	66	0	970,337	36	1	0	2	33	425,400	0	86
District 4	114	25	14	6	67	2	625,773	35	3	2	0	30	208,983	0	67
East	99	49	10	0	40	0	475,360	26	3	0	0	23	127,832	0	47
District 7-B	211	93	3	1	109	5	611,880	57	10	2	1	44	188,691	21	69
West	481	376	4	3	90	8	2,442,984	56	6	0	0	50	313,853	26	454
District 9	310	179	0	11	112	8	912,291	38	7	0	0	31	151,711	24	90
District 10	108	48	15	22	23	0	518,275	11	1	2	0	8	88,136	0	88
Utah	35	30	0	1	4	0	197,086	3	0	0	0	3	14,985	0	75
West Virginia	66	10	0	44	12	0	180,570	1	0	0	1	0	5,530	60	189
Wyoming	60	34	0	6	19	1	304,530	12	2	0	1	9	52,822	9	114
May 1958	4,190	2,042	118	279	1,655	96	17,810,689	861	85	19	22	735	4,240,539	675	4,449
April 1958	3,027	1,528	96	206	1,134	63	13,250,614	555	56	13	11	475	2,665,395	495	4,474
Cum. 1958	19,085	9,489	479	1,425	7,258	434	81,025,550	3,769	356	65	122	3,226	17,922,321	3,013	.....
Cum. 1957	21,980	11,606	192	1,578	8,125	479	91,381,161	5,000	568	53	194	4,185	24,359,259	.....	.....

Note: C.T. = Cable tool comp. Act. op. = Active operations. D.D. = 23; Kans. 2, Wyo. 1, Okla. 18, Texas (1) 1, Calif. 1.

. . . and in western Canada

	TOTAL WELLS							WILDCAT WELLS						
	Total	Oil	Gas	Dry	Service	Footage	1958	Total	Oil	Gas	Dry	Footage	1958
Alberta	92	55	9	18	10	449,939	588	14	3	3	8	61,934	221
Saskatchewan	70	48	1	21	0	306,038	271	16	3	0	13	66,184	74
Manitoba	8	2	0	6	0	16,661	49	2	0	0	2	4,423	4
British Columbia	8	2	3	3	0	48,593	46	6	0	3	3	39,803	37
Northwest Territories	0	0	0	0	0	0	7	0	0	0	0	0	7
Western Canada	178	107	13	48	10	821,231	961	38	6	6	26	172,344	343

& Gas, Ltd., Bailey Selburn Oil & Gas, Ltd., and Catilina Oil Co.

Drilled as a test of the basal quartz horizon ½ mile north of an indicated oil strike in that horizon, the well found it unproductive and was consequently plugged back to the Viking section in which a gas zone was indicated through a misrun drill-stem test. Production casing was set to that sand section and perforated opposite the pay zone. Flow test, through restricted choke, gassed at the rate of 6 M.M.c.f. daily.

Alameda . . . The recent Canadian Devonian strike in Saskatchewan came as welcome news especially when exploration has been cut to a bare minimum of what it was even 1 year ago in that province. Commercial aspects of it, however, will not be known until production tests are carried out as salt water entrusion was encountered during drill-stem tests which also gave up the sought-after crude.

A 15-ft. pay zone in the Mission Canyon sector of the Mission Canyon was indicated at the well, 13-13 Krieger, on LSD 13, 13-4-3w2. At that location the well is 1¼ miles northeast of Imperial's 9-10-4-3 Alameda venture which found an uncommercial oil column in the same zone and 3 miles north of oil production in Alameda oil field.

Border to border, oil men are busy . . .

Drilling in Pennsylvania . . .

DEEP WILDCATTING projects in Pennsylvanian include the following wells: In Crawford County, northwestern Pennsylvania, the 1 Kardosh is drilling in the Queenston at 4,472 ft.

Offshore in Lake Erie New York Natural Gas Co. 1 Block is drilling at 1,270 ft. This is the first offshore operation in Pennsylvania, and the well is being watched closely by the industry.

Manufacturers Light & Heat Co. and New York State Natural Gas Co. are drilling a wildcat on the Negro Mountain anticline in southern Somerset County.

Discovery in Michigan . . .

A new oil prospect 3½ miles south of the Reynolds oil field, best Michigan find since 1955, held top interest as Russell Otterbine 1 Zylstra SE SE SE 29-12n-9w, Winfield Township, Montcalm County, flowed oil in pits from Reed City zone after running 5-in. production string.

Outpost logged Dundee at 3,239 ft. and drilled pay at 3,339 ft. Well filled and flowed 48 hours later. Casing was cemented at 3,337 ft. for later drill-in.

A wildcat drilled ½ mile east of present wildcat 3 years ago swabbed 5 to 15 bbl. oil per day but cut water from same zone and eventually was abandoned.

Devine & Lang 1 Kok NW SE SW 29-5n-14w, Zeeland Township wildcat, Ottawa County, flowed 127 bbl. oil net in 7½ hours from A-1 Salina at 2,789-97 ft. following 350-gal. acid treatment.

The Carter Oil Co. supported test originally was drilled to 3,052 ft. and plugged back to complete in the A-1.

Deepening in Kentucky . . .

In Leslie County on Left Fork of Elkhorn Creek northeast of town of Sizerock, United Fuel Gas Co. is rigging up rotary in preparation for deepening its rank wildcat 28 Fordson Coal Co.

In mid-1957 test (drilled with cable tools) it bottomed at 6,006 ft. and 1,000 ft. below the top of the Knox (Cambro-Ordovician) dolomite.

To date this is the deepest test ever drilled in eastern Kentucky and deepening operations will be watched with much interest by the oil and gas industry.

Naming in Nebraska . . .

Recent field discoveries in the Nebraska portion of the Denver basin were given official names last week by the Nebraska Oil & Gas Commission. Three of the new fields are in Kimball County; one in Banner County.

The new fields and their labels are: Chandler & Simpson 1 Rodman-G, C SE SW 24-15n-55w. Completed for 235 bbl. of oil per day (opens Simpson field); Sunburst Petroleum Co. 1 Hack, C SW SW 34-13n-54w (opens Hack field); British-American Oil Producing Co. 1 Bowman, SE SW 35-16n-55w. Pumped 30 bbl. of oil in 5 hours on completion test (opens Bowman field).

Lewis field is the new producing area in Banner County opened at Stuarco-Lewis Brothers 1 Johnson in C NE NW 30-18n-56w.

And drilling in Nevada

Bonanza Oil Corp. was drilling ahead in hard gray limestone at 1,775 ft. after reporting 14 ft. of oil saturated sand at 1,675 ft. on its wildcat 10 miles southeast of Las Vegas.

SERVICE-WELL DEPTH BREAKDOWN—MAY 1958

	A	B	C	D	E	F
Indiana	2	....	....	....	....	....
Kansas	....	3	6	8	....	....
South Louisiana	....	....	....	....	....	1
New York	....	20	....	....	....	....
Ohio	....	7	2	....	....	....
Oklahoma	2	7	13	....	....	....
Texas	2	13	8	1	....	....
District 2	....	....	1	....	....	....
District 4	1	1	....	....	....	....
District 7-B	1	4	....	....	....	....
West	....	2	5	1	....	....
District 9	....	6	2	....	....	....
Wyoming	....	....	....	....	....	1
Total United States	6	50	29	9	....	2
Alberta	....	....	....	....	10	....

FIELD CONDENSATE-WELL BREAKDOWN—MAY 1958

	D	E	F	G	H	I
Kansas	1	....	....	....	....	....
Louisiana	....	2	4	11	11	1
South	....	2	4	8	9	1
Offshore	....	....	....	3	2	....
East New Mexico	....	....	....	....	1	....
Oklahoma	....	4	2	....	....	....
Texas	3	21	23	14	1	....
District 1	....	....	1	1	....	....
District 2	....	2	4	3	....	....
District 3	....	2	3	6	....	....
District 4	1	6	3	2	....	....
East	1	6	3	....	....	....
District 7-B	1	....	....	....	....	....
West	....	2	....	1	1	....
District 10	....	3	9	1	....	....
Total United States	4	27	29	25	13	1

WILDCAT CONDENSATE-WELL DEPTH BREAKDOWN—MAY 1958

	B	D	E	F	G	H	I
Louisiana	....	....	....	1	1	2	1
South	....	....	....	1	....	1	1
Offshore	....	....	....	....	1	1	....
Mississippi	....	....	....	1	....	....	....
Oklahoma	....	....	2	....	1	....	1
Texas	1	1	2	3	2	....	....
District 2	....	....	1	1	1	....	....
District 4	....	....	1	1	....	....	....
District 7-B	1	1	....	....	....	....	....
District 10	....	....	....	1	1	....	....
Total United States	1	1	4	5	4	2	2

May footage breakdown

	FIELD WELLS					WILDCAT WELLS			
	Oil	Cond.	Gas	Dry	Service	Oil	Cond.	Gas	Dry
Alabama	69,022	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	.....	.....	.....	.....	.....	.....	.....	.....	11,176
Arkansas	61,059	.....	3,517	40,077	.....	11,309	.....	4,855	81,748
California	308,319	.....	36,513	68,409	.....	15,732	.....	3,021	147,063
Colorado	77,621	.....	23,454	74,049	.....	29,227	.....	4,287	191,352
Illinois	180,897	.....	2,617	192,501	.....	2,925	.....	.....	71,254
Indiana	34,856	.....	859	20,557	2,366	.....	.....	.....	42,972
Kansas	469,441	4,891	85,617	374,748	57,609	40,541	.....	18,048	240,829
Kentucky	39,528	.....	67,053	35,356	.....	2,962	.....	.....	15,558
Louisiana	1,087,235	341,685	31,597	609,571	9,725	29,572	62,634	14,401	383,882
North	101,442	.....	31,597	101,301	.....	8,410	.....	8,826	100,237
South	771,095	281,937	.....	373,903	9,725	.....	38,646	5,575	248,178
Offshore	214,698	59,748	.....	134,367	.....	21,162	23,988	.....	35,467
Michigan	42,035	.....	5,815	24,547	.....	3,824	.....	.....	23,232
Missouri	.....	.....	.....	.....	.....	.....	.....	383	.....
Mississippi	85,095	.....	.....	11,340	.....	25,697	9,559	.....	102,751
Montana	83,666	.....	.....	25,882	.....	.....	.....	.....	39,465
Nebraska	86,138	.....	.....	111,378	.....	12,284	.....	.....	161,098
New Mexico	369,716	14,891	113,113	36,620	.....	30,297	.....	.....	67,449
West	69,645	.....	111,648	18,351	.....	1,949	.....	.....	31,436
East	300,071	14,891	1,465	18,269	.....	28,348	.....	.....	36,013
New York	27,050	.....	2,745	.....	27,050	.....	.....	.....	4,231
North Dakota	145,103	.....	.....	45,119	.....	22,457	.....	.....	71,167
Ohio	118,266	.....	54,586	26,073	20,842	.....	.....	4,690	4,100
Oklahoma	880,148	46,201	103,915	464,796	52,834	34,623	42,076	13,134	259,744
Tennessee	.....	.....	.....	.....	.....	.....	.....	600	2,050
Texas	3,536,011	508,297	250,030	1,174,360	56,890	204,291	64,997	29,955	1,507,700
Dist. 1	89,289	19,790	7,169	20,358	.....	6,540	.....	9,036	112,781
Dist. 2	109,236	81,784	70,062	71,984	3,622	29,709	25,085	2,570	116,616
Dist. 3	271,052	104,620	14,100	155,165	.....	11,052	.....	14,564	399,784
Dist. 4	113,286	88,764	24,264	188,014	2,462	18,327	14,257	.....	176,399
East	197,402	68,171	.....	81,955	.....	16,375	.....	.....	111,457
Dist. 7-B	246,588	4,264	.....	163,840	8,497	33,162	5,810	3,785	145,934
West	1,880,465	37,264	9,649	178,665	23,088	39,385	.....	.....	274,468
Dist. 9	452,683	.....	64,479	224,197	19,221	38,081	.....	.....	113,630
Dist. 10	176,010	103,640	60,307	90,182	.....	11,660	19,845	.....	56,631
Utah	173,246	.....	6,129	2,726	.....	.....	.....	.....	14,985
West Virginia	19,262	.....	127,763	28,015	.....	.....	.....	5,530	.....
Wyoming	172,216	.....	25,637	44,399	9,456	8,482	.....	6,268	38,072
Total United States	**8,065,930**	**915,965**	**940,960**	**3,410,523**	**236,772**	**474,223**	**179,266**	**105,172**	**3,481,878**
Western Canada	482,149	.....	32,289	77,729	56,720	25,540	.....	38,515	108,289
Alberta	267,611	.....	30,648	33,026	56,720	15,134	.....	18,054	28,746
Saskatchewan	201,736	.....	1,641	36,477	.....	10,406	.....	.....	55,778
Manitoba	4,012	.....	.....	8,226	.....	.....	.....	.....	4,423
British Columbia	8,790	.....	.....	.....	.....	.....	.....	20,461	19,342

Louisiana field gets extension

PRODUCTIVE LIMITS and potentialities of the widely spread Caillou Island field in the coastal bay waters of Louisiana's Terrebonne Parish were further expanded last week by two additional outpost and new-pay discoveries.

In the East Caillou area, far off the east flank of Caillou Island dome, in Timbalier Bay, The Texas Co. and T-X-L Oil Co. completed a good oil well in a 14,900-ft. sand after drilling to 16,638 ft.

This well, on State Lease 3065, flowed at the rate of 242 bbl. of 36°-gravity oil per day through ⅛-in. choke with pressure of 2,200 psi. and gas-oil ratio of 932 cu. ft. per barrel. Pay is perforated at 14,919-21 ft.

Another east flank well, drilled by The Texas Co. singly, flowed 190 bbl. of 34°-gravity oil per day through 7/64-in. choke with pay at 11,872-88 ft. Its gas-oil ratio is 1,476 cu. ft. Location is on State Lease 2703, about a half mile from nearest production.

New gas discovery completed in Texas

WIDE-OPEN northwestern Kenedy County, in the lower Texas Gulf Coast region, has a new gas-productive area as a result of a discovery last week by Arkansas Fuel Oil Co.

It is located about 5 miles south of Sarita, on the Kleberg County line, and about 5 miles west of the old El Paistle gas area, nearest production of any kind. Arkansas Fuel has more than 17,600 acres under lease in the immediate area.

Discovery well, 1 McGill, was drilled to 11,628 ft. Its casing is perforated two intervals, 10,660-66 ft. and 10,69974 ft., which tested a flow rate of 2,275 M.c.f. per day through 7/32-in. choke with 1,500-psi. pressure. It was drilled to 11,628 ft.

This is 12 to 15 miles southwest along strike from the widespread and multiple-pay May area, in southern Kleberg County, discovered by Arkansas Fuel in 1955 and actively explored and developed by this company since then.

How May field wells classified by depth

	OIL WELLS									GAS WELLS									DRY HOLES								
	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
Alabama	...	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arkansas	2	10	5	1	2	1	...	...	...	...	...	1	...	...	...	...	...	...	...	1	10	...	1	...	...	...	...
California	17	19	14	11	10	5	5	1	...	...	1	...	1	5	...	...	...	...	...	2	3	...	4	2	...	1	...
Colorado	...	...	...	1	14	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	3	11	...	...	...	...
Illinois	10	20	41	3	...	...	...	...	...	5	...	...	...	...	...	...	...	...	10	33	38	1	...	...	...	...	...
Indiana	4	13	3	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	8	4	2	...	...	...	...	...	...
Kansas	...	29	60	47	2	...	...	...	...	...	1	6	11	3	...	...	...	...	...	10	57	34	5	...	...	...	...
Kentucky	21	10	1	1	...	...	...	...	...	1	3	10	5	2	...	...	...	...	19	12	1	...	...	...	...	...	...
Louisiana	2	29	9	2	15	36	28	16	4	1	3	...	...	4	...	...	...	...	5	3	10	8	8	11	18	12	2
North	2	26	7	2	4	...	...	...	...	1	3	...	...	4	...	...	...	...	4	3	8	6	4	2	...	...	...
South	...	3	2	...	3	24	24	15	4	...	...	...	...	...	...	...	...	...	1	...	2	1	4	4	14	10	1
Offshore	...	...	...	...	8	12	4	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	5	4	2	1
Michigan	1	11	2	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	1	3	2	1	...	...	...	...
Mississippi	...	...	...	1	2	...	5	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...
Montana	...	2	2	2	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	2	...	...	...
Nebraska	...	...	...	1	13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	7	12	...	...	...	...
New Mexico	...	8	15	28	16	3	5	1	...	1	3	11	5	7	1	...	...	...	3	1	4	1	1	1	...	...	...
West	...	1	1	2	10	...	...	...	...	1	2	11	5	7	1	...	...	...	...	1	3	...	1	...	...	...	...
East	...	7	14	26	6	3	5	1	...	...	1	...	...	...	...	...	...	...	3	...	1	1	...	1	...	...	...
New York	...	21	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
North Dakota	...	...	6	...	7	5	2	1	...	...	...	...	...	...	...	...	...	...	...	...	2	...	3	2	...	...	...
Ohio	13	...	31	1	...	...	...	...	...	2	9	5	4	1	...	...	...	...	5	3	6	...	...	...	...	...	...
Oklahoma	65	82	68	34	29	14	3	1	...	1	10	4	4	8	...	...	...	...	47	47	39	19	9	7	1	1	...
Texas	84	145	235	116	170	62	28	6	...	...	17	18	6	17	3	...	...	...	48	80	47	51	54	22	7	3	...
Dist. 1	8	7	13	2	4	...	...	...	...	...	...	1	1	...	...	...	...	...	2	6	2	...	...	...	...	...	...
Dist. 2	3	...	1	4	11	2	...	...	...	...	...	6	2	4	2	...	...	...	...	...	3	6	3	2	...	...	...
Dist. 3	7	5	8	1	13	15	2	...	...	...	...	1	1	1	...	...	...	...	6	5	1	8	4	5	4	...	...
Dist. 4	...	2	3	2	12	3	...	...	...	...	...	3	2	1	...	...	...	...	4	5	5	5	12	3	1	2	...
East	10	4	13	3	10	5	...	1	...	...	...	...	...	...	...	...	...	...	4	1	...	2	8	2	...	...	...
Dist. 7-B	12	35	10	10	16	...	...	...	...	...	...	...	...	...	...	...	...	...	15	25	10	9	6	...	...	...	...
West	4	22	135	70	74	34	26	5	...	...	...	3	...	...	...	...	...	...	4	7	7	6	10	4	1	1	...
Dist. 9	40	67	16	24	25	...	...	...	...	...	...	1	...	10	...	...	...	...	13	31	13	15	9	...	...	...	...
Dist. 10	...	3	36	...	5	3	...	...	...	...	17	3	...	1	1	...	...	...	...	...	6	...	2	6	1	...	...
Utah	...	...	...	...	30	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...
West Virginia	...	9	1	...	...	...	...	...	...	...	23	8	10	2	...	...	...	...	1	7	3	1	...	...	...	...	...
Wyoming	2	...	6	9	8	7	...	...	...	...	...	3	...	2	...	...	...	...	2	...	4	...	2	2	...	...	...
Total United States	**221**	**408**	**499**	**258**	**318**	**140**	**82**	**27**	**4**	**12**	**71**	**67**	**47**	**56**	**4**	...	...	...	**148**	**206**	**231**	**128**	**113**	**49**	**26**	**17**	**2**
Western Canada	...	9	15	54	14	9	...	...	...	...	4	...	...	...	3	...	...	...	...	9	4	6	2	1	...	...	...
Alberta	...	6	12	12	13	9	...	...	...	...	3	...	...	...	3	...	...	...	...	4	4	1	1	...	...	...	...
Saskatchewan	...	1	3	40	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	5	1	1	...	...	...
Manitoba	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...
British Columbia	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

NOTE: A = 0-1,250 ft.; B = 1,250-2,500 ft.; C = 2,500-3,750 ft.; D = 3,750-5,000 ft.; E = 5,000-7,500 ft. F = 7,500-10,000 ft.; G = 10,000-12,500 ft.; H = 12,500-15,000 ft.; I = 15,000 ft.

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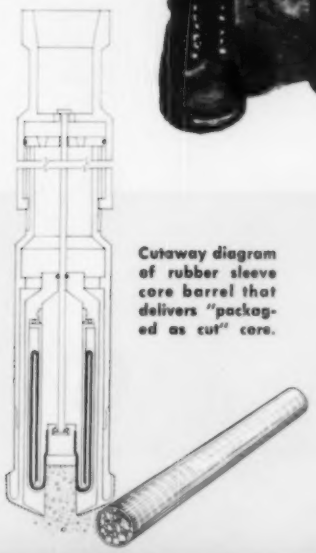

Cutaway diagram of rubber sleeve core barrel that delivers "packaged as cut" core.

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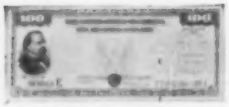

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How May wildcats classified by depth

	OIL DISCOVERIES									GAS DISCOVERIES									DRY HOLES								
	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
Arizona																			1			1	1				
Arkansas			1			1							1						1	2	9	1	4	1	1		
California		1	1				1					1							4	5	14	4	3	2	2	1	
Colorado				1	4								1							1	2	7	24	1			
Illinois			1																9	20	8						
Indiana																			15	11	3						
Kansas			3	7								1	2	1						3	32	30	1				
Kentucky		2																	2	5	2						
Louisiana						2		1						1	1					1	6	6	5	7	8	8	3
North						1									1					1	2	6	3	3	2		
South														1							4		1	4	6	6	3
Offshore						1		1															1			2	
Michigan				1																3	4	1					
Mississippi					1				1										1			1	3	1	4	2	
Montana																			2	3	1	1	2		1		
Nebraska					2																	4	23				
New Mexico		1						2											1	2	1	5	6				
West		1																	1	1		1	4				
East								2												1	1	4	2				
New York																						1					
North Dakota			1		1		1														2		7	1	1		
Ohio													1									1					
Oklahoma	1	1	1	1	3	1								2					31	5	9	8	13	7		1	
Tennessee										1									2								
Texas	2	4	8	4	12	4	4					2	1	2	1				29	50	33	44	68	43	15	3	
Dist. 1	1		2									1		1					14	18	8	4	5				
Dist. 2				1	1	1	1					1										2	10	4	1		
Dist. 3							1							1	1					1	2		3	21	5	1	
Dist. 4			1		1	1														3	5	2	13	5	1	1	
East			1		2														4	1	1	7	8	1	1		
Dist. 7-B	1	3	3	1	2								1						8	8	6	12	10				
West		1	1		1	2	1												2	9	7	6	10	10	5	1	
Dist. 9				2	5														1	10	2	10	8				
Dist. 10							1														2	1	1	2	2		
Utah																				1			2				
West Virginia														1													
Wyoming	1				1									1					3	1		1	2	2			
Missouri										1																	
Total United States	**4**	**9**	**16**	**14**	**24**	**8**	**6**	**3**	**1**	**2**		**4**	**6**	**8**	**2**				**101**	**113**	**126**	**116**	**164**	**65**	**32**	**15**	**3**
Western Canada		1	2	2		1					1	1	1	1	1		1			1	11	11	1	2			
Alberta			2			1					1	1					1				6	2					
Saskatchewan		1		2																	4	8	1				
Manitoba																				1	1						
British Columbia														1	1	1						1		2			

NOTE: A = 1,250 ft; B = 1,250-2,500 ft.; C = 2,500-3,750 ft.; D = 3,750-5,000 ft.; E = 5,000-7,500 ft.; F = 7,500-10,000 ft.; G = 10,000-12,50 ft.; H = 12,500-15,000 ft.; I = 15,000 ft. plus.

Top Pipeliner Has New Role

D. MICHAEL CURRAN, after serving the contracting business for 20 years, is back on the inside of the construction industry which he learned from his father.

In his new job as a senior vice president of Williams Brothers, Curran will be using his insight gained as a developer and manufacturer of special equipment in the world-wide arena in which the Tulsa-based pipeline construction and engineering firm operates.

His experience in construction work goes back to his teenage days under the tutelage of his father, an engineer and highway contractor in Springfield, Mo. "Those were the days," he recalls, "when a contractor's biggest item of expense during the off season in winter was a feed bill for the horses."

He studied business administration and engineering at Drury College and Ohio State University, then left college in 1938 to work for a glass company.

In 1946 he joined M. J. Crose in organizing M. J. Crose Manufacturing Co., Inc., Tulsa. Starting with $12,000 of paid-in capital, the firm grew to be the largest manufacturer of specialized pipeline construction equipment in the world and a major supplier of materials.

Helped change industry . . . Construction methods have changed since the days when the big winter worry was feeding the horses.

Mike Curran has had an active role in this change the past 12 years. His stature in the pipeline industry has enjoyed a growth corresponding to that of the industry itself in postwar years.

He had a part in introducing the spray-type coating and wrapping machine in general use today, the big-inch road-boring machine, the ditch padder, and in developing the first mechanical internal lineup clamp. The Crose firm also was involved in developing the most advanced mechanized welding technique and automatic pipe-handling yard used in double-jointing pipe.

Curran continued as president of M. J. Crose Manufacturing when it was sold to Graham-Paige in 1956.

Personals

William M. Frizzell, district manager in San Bernardino, Calif., for General Petroleum Corp., has been transferred to San Mateo, Calif., as manager of the central division. He succeeds **Jack Byers,** recently named southwest division manager.

Standard Oil Co. (Ind) has promoted five scientists to the position of coordinator. They are **Claude O. McKinney,** coordinator of catalytic cracking; **Waldemar R. Hertwig,** catalytic reforming; **John H. Lovett,** alkylation and polymerization; **Moses Gordon,** final treatment of gasolines and other fuels; and **Robert J. Austin,** control and recovery of wastes. Coordinators will supervise application of research in their fields and act as consultants to Indiana Standard refineries.

Marvin J. Den Herder, group leader in research on hydrocarbon reactions at the Whiting, Ind., research laboratories of Standard Oil Co. (Ind.), has been named a section leader. **Garbis H. Meguerian** and **Keith W. McHenry, Jr.,** have been appointed group leaders at Whiting. Meguerian will be concerned with combustion problems. McHenry will work primarily with catalyst development and improvement.

George E. Mays has been transferred from New York to Hamburg, Germany, by Standard Oil Co. (N. J.). Mays will be assistant to **L. W. Finlay,** chairman of the company's coordination committee for Europe and shareholders' representative in Germany, Belgium, and the Netherlands. In New York Mays was corporate contacts assistant for Jersey affiliates in the Scandinavian countries.

Douglas McGinness, district geologist for Apache Oil Corp., has joined National Cooperative Refinery Association. He will head the company's new southwestern Kansas district geological office, which probably will be located at Liberal.

Burdette A. Ogle, Denver division manager for William Ross Cabeen & Associates, has been promoted to manager of exploration. He will headquarter in Los Angeles. **Craig R. Norton,** division engineer in Denver, has been promoted to chief engineer and transferred to Los Angeles. **A. O. Saterdal,** division geologist in Denver, will succeed Ogle as Rocky Mountain division manager. **Paul Westrup** succeeds Norton as Denver division engineer. **Earl Griffith,** formerly with Tennessee Gas Transmission Co., will replace Saterdal as Denver district geologist.

He resigned in March and this month went with Williams Brothers.

Faith in future . . . At a time when the pipeline-construction boom exceeded the expectations of almost everyone, Curran built an organization which grew with the boom, soon becoming national and then international in scope. His confidence in a continued high level of pipeline construction remains.

"The world needs more energy," he explains, "and the best way to transport the oil and gas which will supply much of the energy is by pipeline."

The current activity of Williams Brothers is an indication of industry activity as a whole. The company has pipeline and other projects going in the United States, Canada, Austria, Turkey, Iran, Venezuela, Bolivia, Chile, Paraguay, and Costa Rica.

Curran also brings an oil-producing background to his new responsibility with Williams Brothers, which has interests in concessions in Bolivia and Paraguay.

Curran was in on the early development 5 years ago of oil and gas fields in Hansford and Ochiltree counties in the Texas Panhandle. He participated in the drilling of several wells with 17 of the first 18, including 3 wildcats, being producers.

Curran owns a cattle ranch in his native Montana, near Great Falls, and finds his relaxation in hunting and fishing. He is married to the former Kathleen Belknap of Detroit, his college sweetheart. They have six children.

Christopher E. Loeser and **Arthur K. Scott** have been named engineering associates by Esso Research & Engineering Co. Loeser joined Esso in 1947. Scott has been with the company since 1936.

Dr. Frank G. Pearce has been appointed director of project engineering for Amoco Chemicals Corp. Pearce was supervisor of the process design section in Pan American Petroleum Corp.'s research department before joining Amoco.

D. H. Hushion, assistant chief engineer for Alberta Gas Trunk Line Co., Ltd., has moved up to chief engineer. He succeeds **Eldon V. Hunt,** who was recently named general superintendent of operations. A graduate of Colorado College, Hushion was with Colorado Interstate Gas Co. before joining Alberta Gas Trunk Line last year.

James H. Helland, formerly with J. M. Hancock, Beeville, Tex., independent, has opened offices in San Antonio, Tex., as a consulting geologist.

T. E. Tucker, assistant district superintendent for Amerada Petroleum Corp., has been transferred to Lafayette, La., from Port Allen, La.

David E. Sibley has been promoted by Shell Oil Co. from junior exploitation engineer to exploitation engineer. He transfers to Donaldsonville, La., from Houston.

Rollin P. Eckis, executive vice president of Richfield Oil Corp., has been elected to the board of trustees of Pomona College, Claremont, Calif. A Pomona alumnus, Eckis has been with Richfield since 1937.

S. L. Pease, coordinator of technical training in the technical-services division of Shell Development Co., has been named manager of the training department in the reorganized exploration and production research division. **D. E. Broussard,** senior engineer in the division, becomes manager of the service engineering department.

Charles M. Kittrell, formerly administrative assistant to the manager of Phillips Petroleum Co.'s supply and transportation department, has been named manager of the company's new New York office of the department. **C. M. McCormick,** industrial-relations director of the department, becomes assistant to the manager of the supply division. **L. A. Whitehair,** formerly administrative assistant to the manager of the pipeline division, will succeed McCormick.

MILLS COX

Mills Cox, executive vice president of Transwestern Pipeline Co., has been elected president and chief executive officer. **John R. McMillan,** executive vice president of Monterey Oil Co. and a director of Transwestern, has been serving as president since formation of the company late last year. McMillan will continue as a director. Transwestern was organized by Monterey, W. K. Warren, and J. R. Butler & Associates, Houston. Cox was vice president of Texas Eastern Transmission Corp. before joining Transwestern last November. He will continue to headquarter in Houston.

Personals

Thomas C. Borland, Canadian division production superintendent for Pan American Petroleum Corp., has been elected vice president, production, and a director of Pan American International Oil Co. He transfers to New York from Calgary. **Jack W. Hamilton,** resident manager for Pan Venezuelan Oil Co., has been appointed resident manager in Tehran, Iran, for Pan American International. In

T. C. BORLAND

J. W. HAMILTON

New York Borland succeeds **Charles F. Bedford,** who was recalled to Tulsa as vice president, production, for Pan American Petroleum. Borland was division engineer at Houston and assistant division production superintendent in Oklahoma City before moving to Calgary in 1955. Hamilton moves to Iran after 2 years as resident manager in Venezuela. He was division landman in Fort Worth and Casper, Wyo., before transferring to Caracas.

E. C. Scurlock, Houston, has moved up from president to chairman of the board of Scurlock Oil Co. and Eddy Refining Co. Replacing him as president of Scurlock Oil is **Jack Blanton,** former vice president. **David E. Farnsworth** was promoted from secretary-treasurer to president of Eddy Refining.

Dan Kozak, Pure Oil Co., has been elected president of the Panhandle Geological Society, Amarillo, Tex. Other officers are **William McBee, Jr.,** Standard Oil Co. of Texas, vice president, and **Clyde Little,** Gulf Oil Corp., secretary. Kozak succeeds **Jack Krisle,** General Crude Oil Co., as president.

J. A. Coddington has moved up from assistant refinery superintendent to superintendent at Ohio Oil Co.'s Robinson, Ill., refinery. **R. W. Stark,** technical adviser to the refinery superintendent, will replace Coddington as assistant superintendent. Coddington succeeds **B. B. Miller,** who was recently named assistant to the president of Ohio.

Personals

ED PARKES

Ed Parkes, executive vice president of United Gas Corp., has been elected president. He succeeds **N. C. McGowen,** formerly president and chairman. McGowen will continue as chairman. Parkes is also president of United Gas Pipeline Co. and Union Producing Co., subsidiaries of United Gas. A graduate of the University of Arkansas, Parkes joined United Gas in 1928. He had served as general superintendent of field pipelines and vice president in charge of gas supply before being named executive vice president in 1955.

W. W. Campbell, formerly superintendent for Baird Engineering Co., Tulsa, has joined Pierce Construction Co., Tulsa, as general construction foreman at the natural-gasoline plant Pierce is building for Anchor Gasoline Corp. at McAllen, Tex.

Herbert H. Jones, formerly chief engineer of the gasoline, carbon black, and refining companies of Sid Richardson Industries, Fort Worth, has opened consulting offices in Dallas. Jones was with Dresser Engineering Co. before joining Richardson Industries. He was also with Phillips Petroleum Co. as chief manufacturing engineer and chief engineer of plant operations at one time.

Ben Weichman has joined Pure Oil Co.'s geological staff at Casper, Wyo. Weichman is a recent graduate of the University of Wyoming.

Boyd Guthrie, superintendent of the Bureau of Mines' oil-shale experiment station at Rifle, Colo., before it was closed in 1955, and recently member of the staff of the Bureau's Laramie, Wyo., petroleum and oil-shale experiment station, has resigned to join Socony-Mobil Oil Co. in Paulsboro, N. J. Socony has oil-shale interests through its subsidiary General Petroleum Corp. Guthrie joins the oil-shale research staff. Guthrie has been with the Bureau of Mines for 27 years. He was superintendent at Rifle from 1944 to 1955.

Robert L. Jones, Houston division geologist for Cities Service Oil Co., has been given a new assignment in evaluation of properties in the company's program of buying producing acreage. **George Field,** assistant division geologist in Houston, will succeed Jones. Jones has been with the company for 30 years. He had been division geologist in Houston since 1942. Field joined the company in 1936. He transferred to Houston as assistant division geologist in 1953.

T. W. G. Thomson, vice president and manager of Texaco Exploration Co., has been named chairman of the board of the Canadian Petroleum Association's new British Columbia division. First vice chairman of the division's 10-man board of directors is **J. H. Van deVenter,** general manager of Gulf States Oil Co. of Canada. **D. L. Potter,** superintendent of Phillips Petroleum Co.'s land and geological section, foreign department, is second vice chairman. Serving on the five-man executive committee with Thomson, Van deVenter, and Potter will be **C. R. Hetherington,** vice president of production and manufacturing, Pacific Petroleums, Ltd., and **D. C. Ion,** general manager, Triad Oil Co. Other directors are **J. A. Armstrong,** Imperial Oil, Ltd.; **E. C. Babson,** Union Oil Co.; **A. O. Detmar,** Mobil Oil Co. of Canada, Ltd.; **G. H. Galloway,** Pan American Petroleum Corp.; and **Sam Stewart,** Richfield Oil Corp.

J. P. Malott has been promoted by Continental Oil Co. from manager of the production department at Houston to assistant general manager of the Rocky Mountain region. He will headquarter in Denver. Malott succeeds **L. L. Aitken,** who recently resigned to join Utah Southern Oil Co. as executive vice president. **Wayne E. Glenn,** assistant Rocky Mountain region production manager for Conoco

J. P. MALOTT

W. E. GLENN

since 1952, moves up to manager of the headquarters production department at Houston, succeeding Malott. A graduate of New Mexico School of Mines, Malott joined Conoco in 1935. He moved to Houston in 1939 and has been regional engineer, assistant production manager, and production manager there. Glenn has been with the company since 1943. He is a graduate of the University of Oklahoma.

J. Louis Frank has joined Ohio Oil Co. in Hobbs, N. M., as associate petroleum engineer. Frank is a recent graduate of Texas A & M College.

Casper Geophysical Society Elects Officers

A. C. Austin, center, Ohio Oil Co., has been elected 1958-59 president of the Casper, Wyo., Geophysical Society. George L. Ellis, left, Pan American Petroleum Corp., is vice president. Barry W. Koch, right, Tidewater Oil Co., will be secretary-treasurer.

Personals

J. P. JONES

J. P. Jones, Bradford, Pa., has been reelected president of Pennsylvania Grade Crude Oil Association. He will continue as director of production for the association. Other officers reelected after the association's recent annual meeting include **George J. Hanks,** South Penn Oil Co., first vice president; **A. C. Simmons,** Simmons Oil Co., second vice president; **Fayette B. Dow,** Washington, D. C., vice president and general counsel; **Samuel Messer,** Quaker State Oil Refining Corp., treasurer; **C. L. Suhr,** South Penn Oil, **C. G. Johnson,** Quaker State, and **Glenn E. Scott,** Wolf's Head Oil Refining Co., assistant treasurers. Three new directors were elected to the association's board. They are **T. A. Anderson,** superintendent of Quaker State's St. Mary's, W. Va., refinery; **L. R. Forker,** executive vice president of Quaker State; and **R. W. Grunert,** senior vice president of South Penn Oil.

Dr. Henry L. Purdy, executive vice president of B. C. Electric Co., Ltd., has been elected 1958 president of the Canadian Gas Association. He succeeds **H. C. Darroch** of Toronto.

Frank M. Jacobson, vice president of Murphy-Canada Oil Co., has been elected president and a director of Amurex Oil Co. **Paul C. McDonald,** vice president of Murphy Corp., becomes a director of Amurex. They succeed **W. L. Falconer** and **Oliver H. Payne,** who have resigned. Falconer, former president, is president and a director of Ponder Oils, Ltd. Payne, former director of Amurex, is a director of Ponder Oils, Ltd. Ponder recently sold 600,000 shares in Amurex to Murphy Corp.

William T. Hayes, recent graduate of the University of Tulsa, has joined Dowell as junior engineer in Farmington, N. M.

Wes Bruer, geologist with Superior Oil Co., has been transferred to Casper, Wyo., from Bakersfield, Calif.

V. C. Watson, tool pusher for Penrod Drilling Co., has been transferred to Alvin, Tex., from Haynesville, La.

H. F. Prioleau, president of Standard-Vacuum Oil Co., was awarded the Philippine Legion of Honor in ceremonies at the New York office of the Philippine consul general last week. Prioleau received the award for demonstrating great confidence in the Philippine Government. Stanvac is currently building a $33.5-million refinery at Bataan. The plant will make Stanvac the largest investor in the Philippines.

L. C. RITTS

L. C. Ritts, Jr., Texas-Louisiana Gulf Coast division exploration superintendent for Pan American Petroleum Corp., has been transferred to Tulsa from Houston and promoted to manager, exploration operations. He will coordinate exploration in the U. S. and Canada. **John C. Johnston,** exploration superintendent of Pan Am's Rocky Mountain division, transfers from Casper, Wyo., to Houston to succeed Ritts. Johnston will be succeeded as Rocky Mountain division exploration superintendent by **Leland C. Adams,** Lafayette, La., district exploration superintendent. Ritts, new exploration manager, joined Pan American in 1947. He was division geologist at Houston before being named Gulf Coast division exploration superintendent in 1956.

D. H. Thornbury, executive vice president and a director of Mid-Continent Supply Co., has been elected president. He succeeds **Ken W. Davis,** who moves up to chairman of the board. A graduate of the University of Alabama, Thornbury joined Mid-Continent in 1929 as Houston district manager. He was named vice president a year later. He has been executive vice president and a director since 1947.

THORNBURY

KEN W. DAVIS

Lyman Dennis, formerly division geologist for Russell McGuire, Dallas independent, has joined Wilcox Oil Co. as staff geologist in Tulsa. Dennis was a consulting geologist in Wichita Falls, Tex., before joining McGuire. He was with Pure Oil Co. before that time.

William A. Watkins, assistant to the vice president in charge of conservation for Carter Oil Co., has retired. He had been with Carter and other Standard Oil Co. (N. J.) affiliates for 33 years. Watkins transferred to Carter in 1935 from Standard Oil Co. of Argentina. He was division superintendent for the company in Seminole, Okla., Mattoon, Ill., and Shreveport, La., before becoming general superintendent of production in 1945. He was named to his present position in 1951.

DEATHS

Charles F. Bisett, Jr., 54, independent oil producer, died June 20 at his home in Tulsa.

Matthew T. Murray, geophysicist with Standard-Vacuum Oil Co., White Plains, N. Y., died recently of a coronary thrombosis. He was 46. Since 1950 Murray's main assignment had been to Stanvac interests in the Far East.

Clyde O. Dorrance, 69, retired production superintendent for the old Kanotex Refining Co., died June 22 in Arkansas City, Kans. Kanotex was later bought by Anderson-Prichard Oil Corp.

U. V. Seales, 62, a vice president and secretary-treasurer of Hunt Tool Co., died June 17 at his home in Houston. He had been with Hunt since 1934.

H. D. Partridge, 57, Bartlesville, Okla., superintendent of surplus material sales for Cities Service Oil Co., died June 23 in Bartlesville in an automobile accident.

Arch D. Kennedy, 71, retired Tulsa drilling contractor, died June 22 in a Tulsa hospital. Kennedy was a purchasing agent for Tidewater Oil Co. before helping to form Exchange Drilling Co. in Tulsa. He retired in the 1940's after Exchange was dissolved.

Louis W. Bennett, 68, treasurer of D-X Sunray Oil Co., died June 21 at his home in Tulsa. He was treasurer and a director of Sunray Oil Co. before it became Sunray Mid-Continent Oil Co. in 1955.

A quick look at the highlights . . .

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,326,000	UP	9,000	DOWN	948,000
Crude stocks	260,465,000	DOWN	2,595,000	DOWN	12,727,000
Completions	1,004	UP	141	DOWN	31
Refinery runs	7,522,000	DOWN	137,000	DOWN	337,000
Gasoline stocks	187,973,000	DOWN	2,268,000	DOWN	1,252,000
Kerosine stocks	23,738,000	UP	779,000	DOWN	4,237,000
Distillate stocks	99,883,000	UP	3,189,000	DOWN	10,399,000
Residual stocks	63,596,000	UP	203,000	UP	19,711,000
Four-product stocks	375,190,000	UP	1,903,000	UP	3,823,000
Total imports	1,654,600	UP	150,400	UP	301,800

Drilling Will Gain Next Quarter

. . . *But Not Enough to Top Last Year*

BY JOHN C. CASPER

Economics Editor

TOTAL well completions are down 3,120 wells compared with the same period last year, and there is little chance for important net gains over the next 4 months.

The well-completion chart on this page shows how much drilling has been off since the first of the year. The most important losses were in March and April when the weekly totals were running about 200 wells less than the year before. Completion reports for these 2 months show an average of about 785 wells per week.

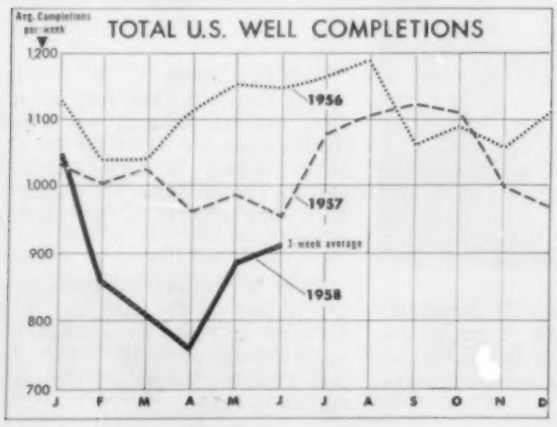
Drilling gains for May and June moved the weekly totals back closer to the levels reported for the same months last year. The average for the first 3 weeks of June was 915 wells per week compared with 952 for the average June week last year.

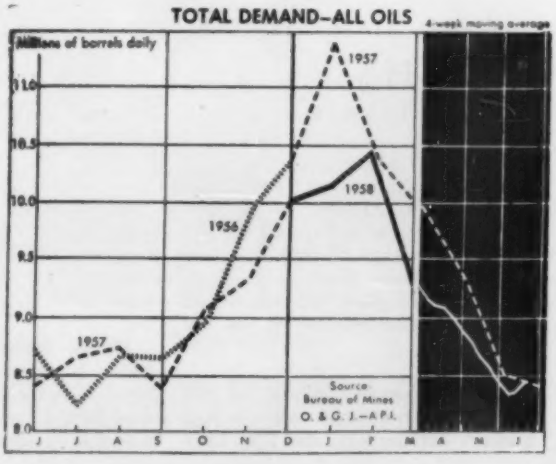
The big question at midyear is how completions in the last half will stack up against the totals for the same period last year. There is a chance that the cumulative total may fall even further behind over the next 4 months. A glance at the chart shows why.

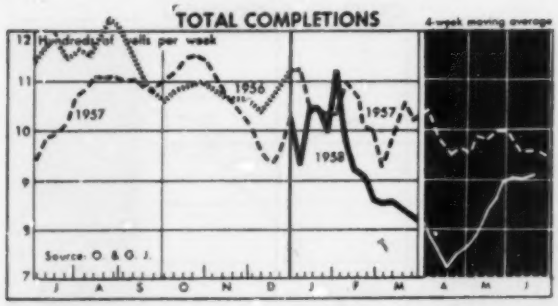
The July-October period in 1957 was the drilling plateau for the year. Completions averaged just over 1,100 wells per week for the 4 months. July completions topped June by 120 wells per week. August was up another 31 wells per week, and September moved up 17 wells more. October was down slightly from September. Drilling will have to average 1,100 wells per week over the next 4 months to prevent a further lag behind last year's completions.

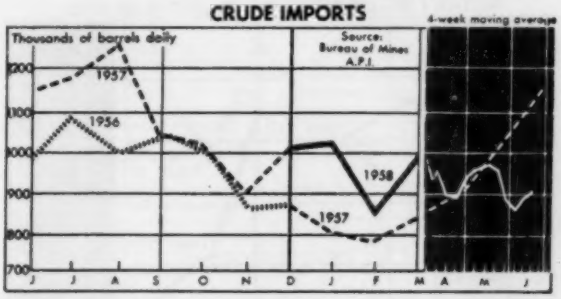
Even if total drilling fails to meet last year's record over the next 4 months, there is a good chance for improvement in the last 2 months of the year. Completions dropped to 987 wells per week for the November-December period last year. An average of 1,100 wells per week for the same months this year would represent a net gain of almost 1,000 wells for the 2-month period.

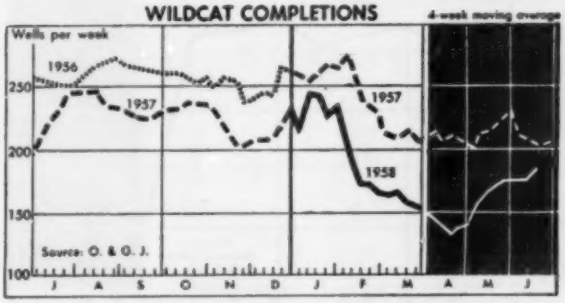
Comparisons for the year will be better than comparisons at the end of October.

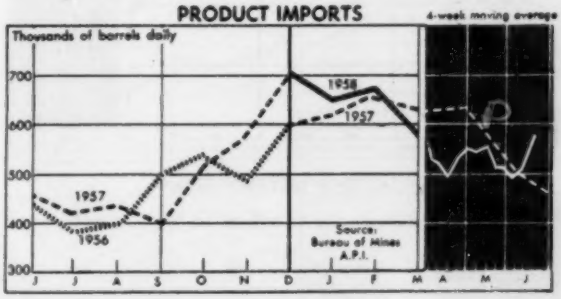










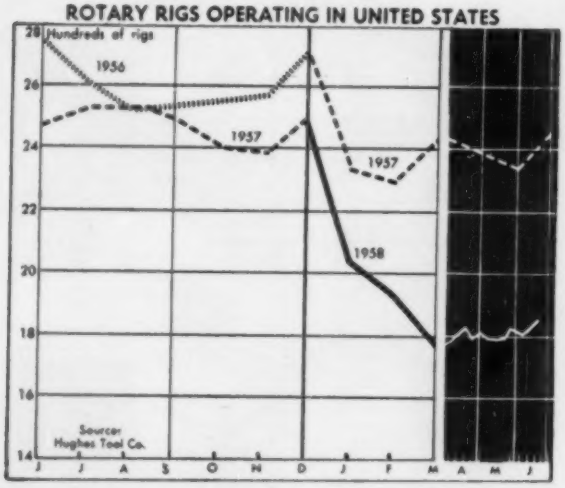


WEEKLY WELL COMPLETIONS . . . WEEK ENDED JUNE 21, 1958

	Total wells							Cumulative		Total wildcats					Cumulative	
	Total	Crude	Cond.	Gas	Dry	Service	Footage	1958	1957	Total	Crude	Cond.	Gas	Dry	1958	1957
Alabama	2	0	0	0	2	0	13,520	39	55	2	0	0	0	2	16	20
Arkansas	11	0	0	0	11	0	38,450	298	454	4	0	0	0	4	77	79
California	28	18	0	3	7	0	144,675	821	1,054	8	0	0	2	6	172	256
Colorado	15	3	0	0	12	0	76,042	344	402	9	0	0	0	9	186	270
Illinois	48	24	0	1	23	0	118,520	902	1,139	5	0	0	0	5	184	281
Indiana	22	9	0	0	13	0	35,487	319	298	8	1	0	0	7	123	58
Kansas	53	22	1	2	26	2	183,022	1,676	1,963	18	2	1	0	15	347	387
Kentucky	39	15	0	0	24	0	49,828	456	645	2	0	0	0	2	49	124
Louisiana	79	36	3	17	23	0	488,305	1,566	1,782	16	1	0	0	15	232	319
North	39	15	0	17	7	0	103,005	539	596	4	1	0	0	3	80	76
South	31	13	3	0	15	0	304,348	815	840	11	0	0	0	11	136	201
Offshore	9	8	0	0	1	0	80,952	212	346	1	0	0	0	1	16	42
Michigan	8	2	0	0	6	0	23,121	180	183	5	1	0	0	4	62	76
Mississippi	9	5	0	0	4	0	81,475	178	171	3	0	0	0	3	89	87
Montana	17	7	0	1	9	0	95,225	180	168	9	0	0	1	8	79	60
Nebraska	19	9	0	0	10	0	108,818	318	373	9	1	0	0	8	151	210
New Mexico	44	29	0	10	5	0	221,336	891	969	5	1	0	1	3	119	132
West	19	9	0	10	0	0	90,706	414	364	2	1	0	1	0	52	48
East	25	20	0	0	5	0	121,630	477	605	3	0	0	0	3	67	84
New York	10	5	0	0	0	5	13,500	259	222	0	0	0	0	0	16	1
North Dakota	6	2	0	0	4	0	33,725	201	133	2	0	0	0	2	66	53
Ohio	18	12	0	4	1	1	53,408	482	503	0	0	0	0	0	5	3
Oklahoma	133	56	1	8	62	6	450,515	3,103	2,978	22	2	1	1	18	425	339
Pennsylvania	*53	14	0	21	13	5	218,781	237	354	1	0	0	0	1	7	35
Texas	353	183	18	21	125	6	1,523,864	8,495	10,328	78	11	2	3	62	1,755	2,619
District 1	20	4	0	0	16	0	47,521	477	595	12	0	0	0	12	196	204
District 2	27	3	8	4	12	0	216,026	372	344	6	1	0	1	4	96	139
District 3	26	9	5	2	9	1	186,264	621	876	8	2	1	0	5	129	261
District 4	19	8	3	1	7	0	101,659	576	684	3	1	1	0	1	167	244
East	19	9	0	0	10	0	73,395	570	591	5	0	0	0	5	164	181
District 7-B	51	20	0	0	30	1	137,835	1,104	1,332	17	2	0	0	15	314	499
West	106	87	1	3	15	0	496,960	2,507	2,955	15	2	0	2	11	353	444
District 9	58	32	0	2	20	4	159,909	1,681	2,309	9	3	0	0	6	285	600
District 10	27	11	1	9	6	0	104,295	587	642	3	0	0	0	3	51	47
Utah	7	3	0	1	3	0	41,981	201	82	2	0	0	0	2	37	46
West Virginia	17	6	0	9	2	0	37,793	323	296	0	0	0	0	0	10	13
Wyoming	9	6	0	1	2	0	49,473	331	381	1	1	0	0	0	94	127
Misc. (Tenn., Fla.)	†4	0	0	0	4	0	15,767	45	32	4	0	0	0	4	39	25
Total U. S.	**1,004**	466	23	99	391	25	4,107,631	21,845	24,965	**213**	21	4	8	180	4,340	5,620
Total prev. week	863	399	17	55	373	19	3,575,089	.....	.....	180	17	0	2	161	.....	.....
Cum. 1958	21,845	10,799	540	1,641	8,349	516	92,191,112	.....	.....	4,340	411	73	135	3,721	.....	.....
Western Canada	61	33	0	12	16	0	268,352	1,089	1,239	13	1	0	3	9	369	331

*May total. †Fla. 1 dry, 11,946 ft.

ROTARY RIGS OPERATING IN UNITED STATES

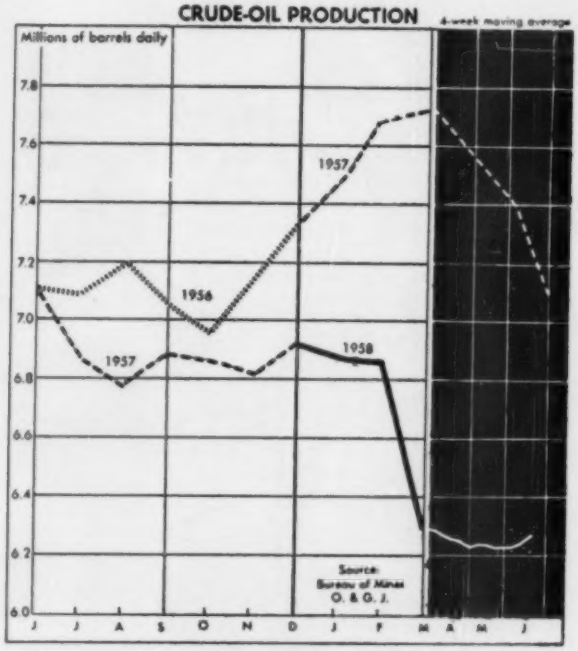


ACTIVE ROTARY RIGS*

	6-23-58	6-16-58	6-9-58	6-24-57
Alabama	5	5	5	9
Arkansas	18	19	24	21
Arizona	....	....	....	....
California	83	77	78	107
Colorado	46	45	36	42
Florida	1	1	1	1
Georgia	....	1	1	....
Idaho	....	....	....	....
Illinois	56	71	52	49
Indiana	5	11	10	6
Iowa	3	3	3	2
Kansas	125	128	141	170
Kentucky	8	10	12	11
Louisiana	293	276	270	435
North	37	39	35	56
South	215	198	193	275
Offshore	41	39	42	104
Maryland	....	....	....	....
Michigan	8	6	5	13
Missouri	....	....	....	1
Montana	17	17	15	28
Mississippi	37	39	39	42
Nebraska	21	25	24	39
Nevada	....	....	....	....
New Mexico	124	129	123	158
New York	2	2	2	....
North Dakota	32	35	34	24
Ohio	....	....	....	1
Oklahoma	183	179	173	230
Oregon	1	1	1	1
Pennsylvania	10	9	10	15
South Dakota	....	....	....	1
Texas	663	639	643	1,040
Gulf Coast	134	122	126	211
Offshore	5	3	3	5
West	250	251	250	385
North	235	225	220	371
East	39	38	44	68
Tennessee	....	....	....	....
Utah	38	37	36	45
Washington	....	....	....	....
West Virginia	8	8	8	3
Wyoming	65	61	57	70
Virginia	....	....	....	....
Total United States	1,852	1,834	1,803	2,564
Western Canada	151	164	155	221
Eastern Canada	3	3	3	1
Grand total	2,006	2,001	1,961	2,786

*Hughes Tool Co.

CRUDE-OIL PRODUCTION

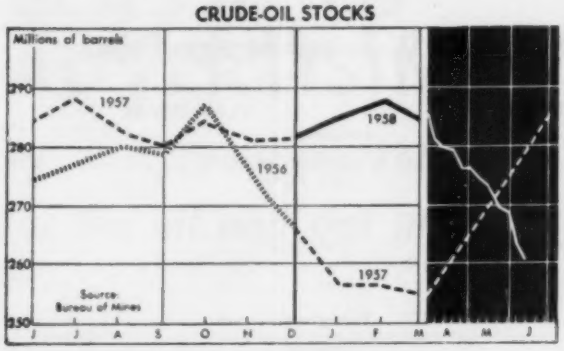


DAILY AVERAGE PRODUCTION FOR WEEK

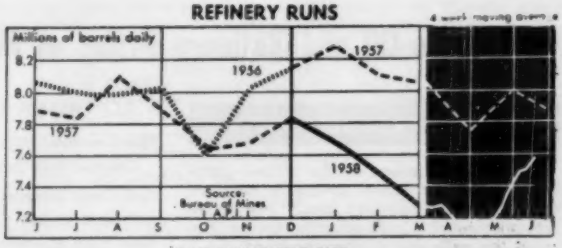
	June 21, 1958			
	Crude oil	Lease condensate	Total	June 14 total
Alabama	14,850	.....	14,850	15,000
Arkansas	75,150	150	75,300	76,100
California	848,600	.....	848,600	849,200
Colorado	131,100	.....	131,100	133,025
Eastern	46,800	.....	46,800	50,700
Florida	1,275	.....	1,275	1,275
Illinois	229,800	.....	229,800	229,300
Indiana	31,500	.....	31,500	31,800
Kansas	†329,300	.....	†329,300	†339,650
Kentucky	43,700	.....	43,700	44,000
Louisiana	727,800	86,675	814,475	815,775
North	109,800	2,900	112,700	114,000
South	618,000	83,975	701,775	701,775
Michigan	26,100	.....	26,100	26,300
Mississippi	93,200	4,500	97,700	97,700
Montana	78,600	.....	78,600	74,700
Nebraska	52,950	.....	52,950	52,250
Nevada	100	.....	100	100
New Mexico	271,100	5,700	276,800	§276,800
North Dakota	35,700	.....	35,700	35,200
Oklahoma	†545,800	.....	†545,800	†540,900
Texas	2,205,000	65,000	2,270,000	2,270,000
Dist. 1	45,500	400	45,900	45,900
Dist. 2	90,000	8,600	98,600	98,600
Dist. 3	315,000	32,000	347,000	347,000
Dist. 4	163,000	8,200	171,200	171,200
Dist. 5	25,500	300	25,800	25,800
Dist. 6	92,000	7,000	99,000	99,000
East Texas Field	120,000	.....	120,000	120,000
Dist. 7-B	122,000	100	122,100	122,100
Dist. 7-C	117,000	4,050	121,050	121,050
Dist. 8	817,000	1,900	818,900	818,900
Dist. 9	192,000	1,800	193,800	193,800
Dist. 10	106,000	650	106,650	106,650
Utah	75,200	.....	75,200	76,400
Wyoming	299,850	.....	299,850	302,850
Others	‡150	.....	‡150	‡150
Total U. S.	6,163,625	162,025	**6,325,650**	6,339,175
Change from previous week, down			**13,525**	
Canada	†461,500	.....	†461,500	†399,200
Total U. S. production—January 1-June 21				1,111,508,300 bbl.
Same period last year (crude plus cond.)				*1,293,124,013 bbl.

*Includes 24,400,175 bbl. condensate. †Week ended previous Monday. ‡South Dakota. §Revised.

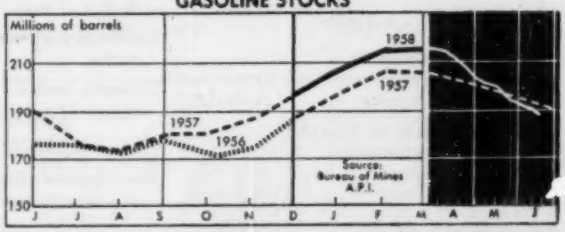
CRUDE-OIL STOCKS



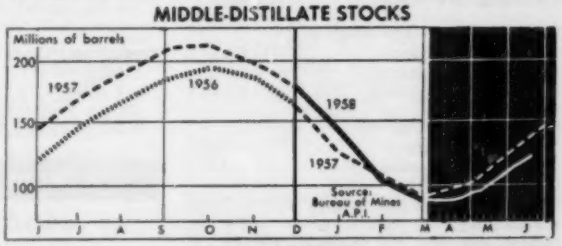
REFINERY RUNS



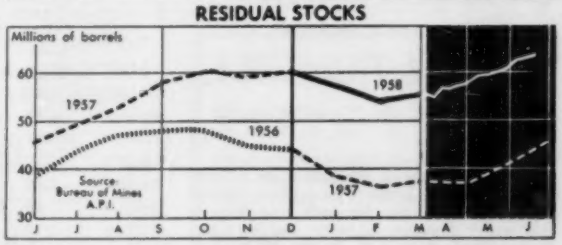
GASOLINE STOCKS



MIDDLE-DISTILLATE STOCKS



RESIDUAL STOCKS



CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

	6-14-58	6-7-58	6-15-57
Pennsylvania	2,899	2,878	2,718
Other Appalachian	1,629	1,465	1,871
Illinois, Indiana, and Michigan	11,103	11,344	9,483
Nebraska and North Dakota	2,419	2,150	2,416
Kansas	10,378	10,085	11,292
Oklahoma	16,360	16,881	20,995
Arkansas	2,257	2,215	2,861
Louisiana	16,358	16,482	18,392
North	2,822	2,891	2,818
South	13,536	13,591	15,574
Mississippi, Alabama, and Florida	2,037	2,066	2,566
New Mexico	7,658	7,646	7,941
Texas	108,737	111,039	127,829
East Texas	7,386	7,241	11,475
West Texas	51,771	53,093	61,342
Texas Gulf	20,963	21,849	24,312
Other Texas	28,617	28,856	30,700
Wyoming	14,310	15,557	16,798
Other Rocky Mountain	8,103	7,817	5,914
California	39,178	38,819	27,257
Foreign	†17,039	16,616	15,894
Total	260,465	263,060	274,227

*Bureau of Mines. †Includes 4,992,000 bbl. in California.

API REFINERY REPORT—JUNE 20, 1958

(Thousands of barrels)

District—	Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.	Stocks‡—Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, June 1957—Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.
East Coast	1,097	461.9	25.0	283.0	191.7	44,252	9,428	31,572	12,855	1,210	498.0	21.3	300.8	223.2
Appalachian:														
District 1	95	45.7	2.9	20.3	3.1	4,699	539	2,134	575	101	44.7	3.2	20.7	4.6
District 2	105	57.3	3.4	18.0	7.9	2,744	422	1,031	341	58	34.2	3.6	7.6	7.3
Ind., Ill., Ky.	1,388	743.9	61.6	272.0	131.4	34,866	4,912	16,520	5,308	1,340	684.7	57.1	263.7	157.0
Minn., Wis., Dak.	108	51.7	6.0	28.7	10.0	7,050	1,078	4,941	531	99	47.7	6.9	26.4	8.1
Okla., Kans., Mo.	749	424.1	12.7	176.4	22.1	16,518	1,285	9,134	900	719	402.4	12.9	168.7	28.6
Inland Texas	262	204.0	6.0	43.4	19.6	6,286	342	1,555	2,075	275	204.8	9.4	51.5	21.9
Texas Gulf Coast	1,670	840.0	83.4	414.8	185.4	23,636	2,724	10,194	5,963	1,869	932.6	72.8	491.1	227.8
La. Gulf Coast	571	358.7	51.8	130.3	48.6	9,648	1,578	4,426	1,449	653	369.5	53.7	172.7	51.5
N. La. and Ark.	89	40.0	2.9	23.0	7.3	4,453	867	2,295	147	93	33.7	5.2	21.4	6.8
Rocky Mountain:														
New Mexico	20	8.6	1.1	4.6	2.9	687	19	157	67	27	13.4	.3	5.5	2.8
Other Rocky Mt.	298	135.7	5.6	60.6	32.7	6,575	233	2,751	931	292	137.4	2.2	65.6	32.8
West Coast	1,070	463.1	2.0	141.6	276.6	26,559	311	13,173	32,454	1,131	478.1	5.3	177.0	328.7
June 20, 1958	7,522	3,834.7	264.4	1,616.7	939.3	187,973	23,738	99,883	63,596	7,867	3,881.2	253.9	1,772.7	1,101.1
June 13, 1958	7,659	3,851.4	266.7	1,659.0	922.7	190,241	22,959	96,694	63,393	.....	.....	.....	.....	.....
June 21, 1957	7,859	3,901.9	270.7	1,678.7	1,102.3	189,225	27,975	110,282	43,885	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipe lines.

Crude-Oil and Refinery Prices at Representative U. S. and Foreign Points

REFINED-PRODUCT PRICES

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (89 octane)	11.75-12.00
Premium (99 octane)	14.75-15.00
Gulf Coast (cargoes for coastwise or export movements):	
★ Regular (90 octane)	10.00-10.50
★ Regular (92 octane)	10.25-10.75
★ Premium (97 octane)	11.625-12.00
★ Premium (98 octane)	12.125-12.75
California (rack) (Los Angeles):	
Regular (88 octane)	11.3-11.5
Premium (96 octane)	12.8-13.0
Premium (98 octane)	13.3-13.5
Caribbean area (cargoes):	
Regular (87 octane)	9.625
Premium (98 octane)	12.125

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

NATURAL GASOLINE*

Group 3:	
Grade 26-70	4.5
Breckenridge:	
Grade 26-70	4.0

*If 26-70 natural is considered as 100 per cent, prices for lower-vapor-pressure grades increase 2.5 per cent for each unit drop in Reid vapor pressure down to and including 16 lb. Prices for grades below 16 lb. may vary slightly by areas or plants.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	9.25-9.50
Diesel oil (58 d.i. and above)	8.875-9.125
Distillate No. 1	8.875-9.125
Distillate No. 2	8.25-8.50
Gulf Coast (cargoes):	
Kerosine 41-43	8.50-8.75
Distillate No. 2	8.125-8.25
New York Harbor (barges):	
Kerosine 41-43	9.35
Distillate No. 2	8.85
Diesel fuel, 48-52 d.i.	9.45
Caribbean area (cargoes):	
Distillate No. 2	8.125

WAX (LB.)

Oklahoma (Group 3):	
132-135 A.m.p. (semi-refined) in tank cars	6.50
New York (export):	
126-130 A.m.p. crude-scale (solid in bags or barrels)	7.35

★Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
Residual fuel (max 1% S)	$1.25-1.30
Gulf Coast (cargoes):	
Bunker C fuel	$2.20-2.25
New York Harbor (barges):	
Bunker C fuel	$2.57
Caribbean (cargoes):	
Bunker C	$2.25
California (rack):	
Bunker C fuel, Los Angeles	$2.45

LUBRICATING OILS

Mid-Continent (Group 3):	
150-160 bright stock, solvent refined, 0-10 p.p., 95 v.i.	23.0
200 vis. neutral oil, solvent refined, 0-10 p.p., 95 v.i.	20.5
Pennsylvania Grade:	
145-155 vis. at 210, bright stock, 8 color, 25 p.t.	24
200 vis. neutral (180° at 100°), 25 p.t.	22

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	★Signal Hill, Calif.§	Mid-Cont.*	Gulf Coast Tex.†	West Tex.‡ N.M.	Wyo. (sour)
14-14.9	$2.36	....	....	....	....
15-15.9	2.41	....	....	....	$1.81
16-16.9	2.46	....	....	....	1.86
17-17.9	2.51	....	....	....	1.91
18-18.9	2.57	....	....	....	1.96
19-19.9	2.62	....	....	....	2.01
20-20.9	2.68	$2.75	....	$2.62	2.06
21-21.9	2.73	2.77	....	2.64	2.11
22-22.9	2.78	2.79	....	2.66	2.16
23-23.9	2.84	2.81	$3.44	2.68	2.21
24-24.9	2.89	2.83	3.46	2.70	2.26
25-25.9	2.95	2.85	3.48	2.72	2.31
26-26.9	3.00	2.87	3.50	2.74	2.36
27-27.9	3.06	2.89	3.52	2.76	2.49
28-28.9	3.11	2.91	3.54	2.78	2.54
29-29.9	3.16	2.93	3.56	2.80	2.59
30-30.9	3.22	2.95	....	2.82	2.63
31-31.9	3.27	2.97	....	2.84	2.67
32-32.9	3.33	2.99	....	2.86	2.71
33-33.9	3.38	3.01	....	2.88	2.75
34-34.9	3.44	3.03	....	2.90	2.79
35-35.9	....	3.05	....	2.92	2.83
36-36.9	....	3.07	....	2.94	2.87
37-37.9	....	3.09	....	2.96	2.89
38-38.9	....	3.11	....	2.98	2.91
39-39.9	....	3.13	....	3.00	2.93
40 and up	....	3.15	....	3.02	2.95

*Includes Oklahoma (sweet), part of Kansas, North Dakota, W. Texas (sweet). Some Oklahoma available for 15 cents less starting 3-17-58 and other at 10 cents less on 4-1-58. †Low cold test crude. ‡Sour. §Some postings 3-11 cents lower.

Effective dates of broad changes: California, 6-22-58; east of California, January 3-10, 1957; Pennsylvania Grade 6-18-58.

FLAT PRICES

Louisiana:	
Bienville (distillate)	$3.05
Ville Platte	3.45
Texas:	
East Texas	3.25
Conroe	3.53
Van	3.08
Pennsylvania Grade:	
Bradford	3.90
Middle District	3.72
Southwest Pennsylvania	3.43
West Virginia	3.25
Buckeye Grade	3.25
Illinois Basin	3.00
Canada:	
Leduc-Woodbend	2.67
Redwater (Alta.)	2.56
Smiley (Sask.)	2.33
Pembina	2.52

FOREIGN

Venezuela:	
Cumarebo, 48°-49.9°, Tucupido	3.75
San Joaquin, 41°-41.9°, Puerto La Cruz	3.34
Oficina, 35°-35.9°, Puerto La Cruz	3.05
Tia Juana medium, 26°-26.9°, Amuay*	2.55
Quiriquire, 16.0°-16.4°, Caripito	2.30
Lagunillas heavy, flat, Amuay or Las Piedras*	2.25
Bachaquero, flat, 15°-16°, Las Piedras*	2.08

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

Middle East, Persian Gulf (cargoes, f.o.b. lifting port):	
Arabian, 36.0°-36.9°, Ras Tanura	$2.12
Iranian, 34.0°-34.9°, Bandar Masur	2.04
Iranian, 34.0°-34.9°, Abadan	1.99
Iraq, 35.0°-35.9°, Fao	1.98
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.85
Qatar, 41.0-41.9°, Umm Said	2.23
Middle East, E. Mediterranean:	
Arabian, 36.0°-36.9°, Sidon	2.49
Iraq, 36.0°-36.9°, Tripoli, Banias	2.49
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°	2.75

TANKER RATES PER LONG TON

(Latest reported spot fixtures)

★ Gulf-U.S.N.H., dirty (USMC—35%)	$1.85
★ Carib.-U.K., clean (USMC—27.5%)	4.75
Carib.-U.S.N.H., dirty (USMC—57.5%)	1.15
P.G.-U.S.N.H., dirty (USMC—60%)	5.08

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500 TON USED PIPE 2" to 6" GRADE 1-2 and 3. Priced right for quick sale. HEAT & POWER CO., INC., P. O. Box 587, Drumright, Okla.

WELL DRILLS - CORE DRILLS. Everything for well and core drilling in both new and used equipment at money saving prices. Fishing tools rented. Send for bulletins. Pressey & Son, Pueblo, Colo.

FOR SALE at Oklahoma City. One used 125 H.P. Kewanee LFB boiler 250# working pressure, 1264 sq. ft. heating surface. Price $2500.00. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

SALES AND RENTALS. Used cable drilling and fishing tools, casing, production equipment; from the Southwest's largest stock of oil field supplies. Degen Pipe and Supply Co., Tulsa.

FOR SALE OR EXCHANGE—Fully equipped D8 Tractor, D7 Tractor, Mack Truck and Utility Trailer, overhauled six cylinder GMC Power Unit, overhauled four cylinder GMC Diesel Engine, for 36L Bucyrus or Cardwell or equivalent Spudder in good working condition. Contact Ted Pappas, P. O. Box 132, Crescent City, California.

13750 KVA Natural Gas Engine Power Plant consisting of 11—1250 KVA 3/60/2400/4160 Generator Sets will be sold individually. Can be inspected on foundations. Write for pictures and details. HEAT & POWER CO., INC. 60 E. 42 St., NEW YORK CITY

MOTORS AND GENERATORS

1500 HP D.C. MOTORS

1500 HP—525 volts D.C.—600 R.P.M.—NEW—2-bearing continuous duty motors—manufactured by Westinghouse. In original crates. From Navy Destroyer Escort. SPECIFICATIONS: 2-bearing 1500 HP—525 volts DC—2270 amps—600 RPM—ambient temperature 40° C—class B insulation—2-bearing pedestal sleeve type—shunt wound—efficiency 94.23%. ONLY 6 AVAILABLE—BUY NOW AND SAVE. Suitable for steel mill drive—offshore oil rigs—rolling mill drive—dredge pump applications.

1200 KW GENERATORS

(2) Equal to new—manufactured by Allis-Chalmers. 1200 KW—525 volts D.C.—2290 amps—750 RPM—cooling self-ventilated—totally enclosed—separate excitation—continuous duty—class B insulation—Mfg. type M.H.C.—frog leg armature.

The Boston Metals Co.

313 E. Baltimore St. ELGIN 5-5050 — Baltimore 2, Md. LEXINGTON 9-1900

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8⅝" 28 LB. LAPWELD line pipe, 600,000 ft. No. 1 grade. Indiana-Ohio Pipe Co. P. O. Box 333. Phone 3-4674, Decatur, Indiana.

HYDRAULIC CASING pulling business. 2 complete units, each with 2 trucks, pick-up, tools & rippers. Units mounted on trucks. In operation. 25 well contracts goes with business. Only hydraulic casing pulling units in this area. Office & storage building available if desired. Jamison Pipe & Tool Co. Phone 80, Madison, Kansas.

NAT. 130 DRILLING RIG FOR IMMEDIATE SALE IN COLOMBIA

One complete Nat. 130 rig, with all normal auxiliary components. Six years old and has drilled total 118,000 ft.

Rig is in sound operating condition. Sale will be made by bid only. All inquiries and replies should be addressed to:

General Manager
INTERNATIONAL PETROLEUM (COLOMBIA) LTD.
Aparlado Aéreo No. 3533
BOGOTA, COLOMBIA, S.A.
(Telephone: 437-400)

FOR SALE

290—8" New Style 40 Dresser Couplings x 16" long

Complete with bolts and gaskets.

$12.00 each.

Goodman Pipe Corp.

Bradford, Pa.

FOR SALE

1—Clark Triplex pump, 3⅛"x8", 2040 barrels, can be used up to 1800 lbs. sq. inch $3500.00
1—Deming 2¼" Triplex pump—650 barrels at 650 lbs. $375.00
Pumps equipped with stainless steel plunger and bronze valves. Pumps slightly used, excellent condition.
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AUTOMATIC PBX Telephone Equipment 100 circuit with code call and Electric Whistle, 100 wall and desk auto. dial phones and 6 outdoor monophones. Hearhere Acoustic Booth. HEAT & POWER CO., INC., P. O. Box 587, Drumright, Okla.

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MECHANICAL ENGINEER—Cabot Shops, Inc., Pampa, Texas, has immediate opening for Mechanical Engineer with degree and design experience in oilfield drilling and servicing equipment or pumping units. Work involves design of mechanical and structural components, including machine design, stress analysis, pneumatics, hydraulics and power transmission. Resume and details should be addressed: Mr. Bill Kelley, Personnel Department, Cabot Shops, Inc., P. O. Box 1101, Pampa, Texas.

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LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Salt Lake City, Utah. Notice is hereby given that 640 acres of land in three parcels, Parcel 1: SE¼ NE¼, E½ SE¼ Sec. 14, 120 acres; Parcel 2: E½ NE¼ Sec. 23, S½ NW¼, SW¼ NE¼ Sec. 24, 200 acres; Parcel 3: E½ SE¼ Sec. 23, SW¼, NW¼ SE¼ Sec. 24, 280 acres, all in T. 15 S., R. 11 E., SL Mer., Utah, within the known geologic structure of the Farnham Dome Field, Utah, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 1:00 P.M., M.S.T., July 31, 1958, when bids will be opened. Details of the lease offering, how and where to submit bids, may be obtained from the Bureau's Salt Lake City, Utah, office.

SITUATIONS WANTED

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ATTORNEY: 34, married, 10 years' continuing experience, one employer, in gas, electric utility law, 6 years' specialization FPC rate cases. Admitted: Ohio, Florida, USCA(DC), US Supreme Court; member American Bar, Federal Power Bar Associations, Kiwanis International, Phi Delta Phi, Phi Delta Theta. A.B., LL.B., University of Michigan. Box K-731, The Oil and Gas Journal, Tulsa, Oklahoma.

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LANDMAN: 7 years experience including land department management, Mid-Continent and Rocky Mountains. Law degree. Will relocate. Write Box K-752, The Oil and Gas Journal, Tulsa, Oklahoma.

PROJECT CHEMICAL ENGINEER—B.CH.E.—12 years experience in Petro-Chemical operations. Has initiative and record of accomplishments in Technical and Administration fields. Family. Box K-756, The Oil and Gas Journal, Tulsa, Oklahoma.

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LEGAL

Sealed bids will be received until July 15, 1958, 2:00 o'clock, P. M., Mountain Standard Time, and opened at that time in the Office of the Crow Indian Agency, Crow Agency, Montana, for the leasing of 946.65 acres of allotted lands located in T. 3 N., R. 33 E., T. 3 N., R. 34 E., Big Horn County, Montana, for oil and gas mining purposes. The details of the lease offering and how and where to file bids may be obtained by addressing the inquiry to the Superintendent of Crow Indian Agency, at Crow Agency, Montana.

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EQUIPMENT MEN . . . in the news

Sivertsen, Dole become district managers

. . . of the Chicago district and Cleveland district, respectively, of Republic Flow Meters Co., a subsidiary of Rockwell Manufacturing Co.

Clayton Sivertsen joined Republic after graduation from college. He was a sales and service engineer for Republic's Indianapolis, Ind., district office and a project engineer at its general office before this appointment.

John Dole was previously assigned to the Philadelphia district office as a sales and service engineer.

Western Co. constructs new district station

. . . and expands facilities and services at another district, announces H. E. Chiles, Jr., president.

The new installation is presently under construction at Kermit, Tex., to serve Winkler, Ward, Reeves, and Loving counties of West Texas. Operation is slated to begin soon.

The Hobart, Okla., station is expanded to include logging and perforating. Its acidizing facilities and equipment will also be increased. This station serves the Kiowa County area of west central Oklahoma.

The Kermit district will service the western side of the Permian basin, and also the eastern edge of the Delaware basin. These areas were formerly serviced from the company's Odessa district.

Walter Beadle, vice president in charge of operations and sales announced the following personnel at these locations. E. E. Pfaff, formerly district operations manager at the Rankin district, will assume duties of district manager at Kermit, with Bob Peacock as sales supervisor and Dewey Williams as operations supervisor. E. G. Smith has been named wire line engineer at Hobart with D. L. Mull assigned as pumping service engineer.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Santa Fe, New Mexico. Notice is hereby given that approximately 4,369.68 acres of land in eighteen parcels within the known geologic structure of certain fields in Eddy, Lea, Rio Arriba and San Juan Counties, New Mexico will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 2:00 p.m., MST, July 15, 1958, when bids will be opened. Details of the lease offering, how and where to submit bids, may be obtained from the Bureau's Land Office at Santa Fe, New Mexico. Douglas E. Henriques, Manager.

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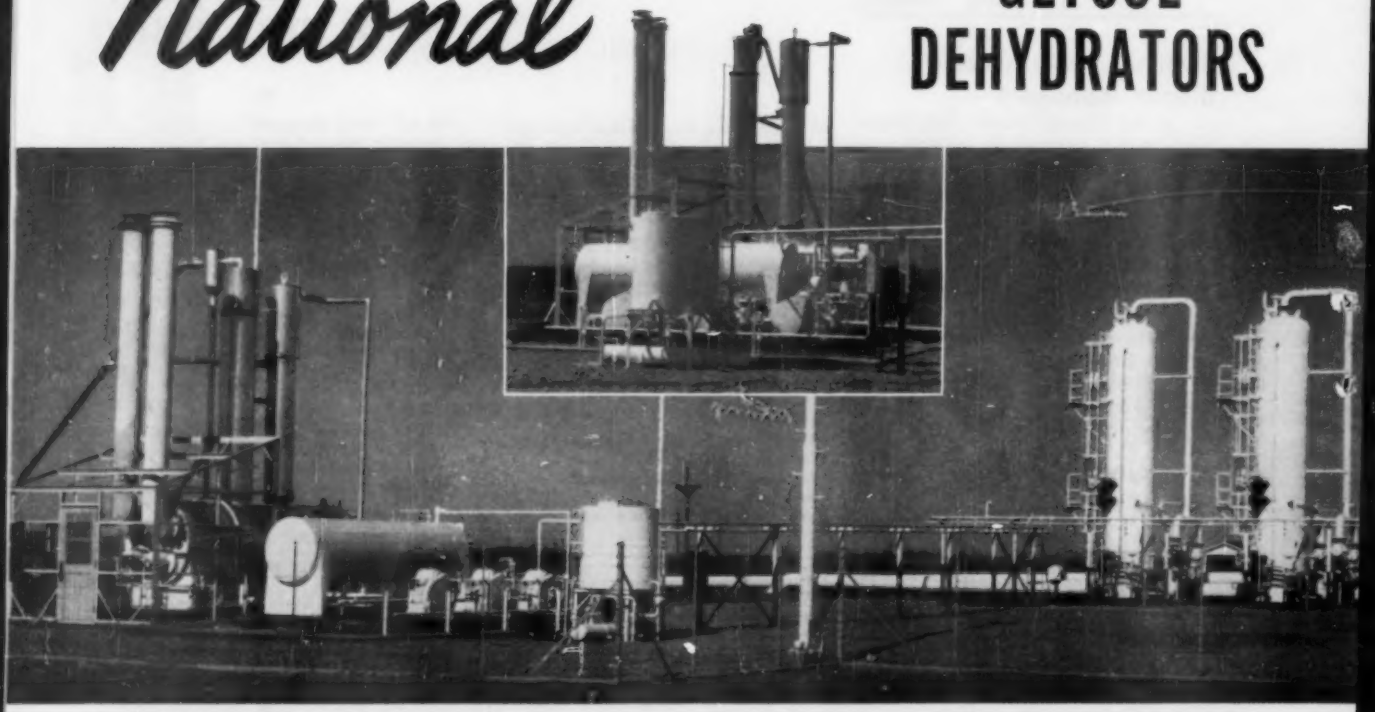

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Automatic Compact Glycol Dehydrators provide for absorption of water from the vapor phase into the dry glycol in the absorber tower. The wet saturated glycol is reconcentrated, followed by recirculation back to the absorber to begin its job all over again.

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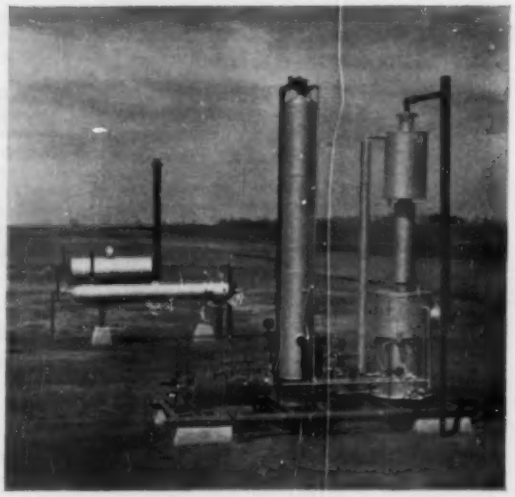
Designed and engineered to afford "packaging" of greatest per cent of the complete unit.

National can handle all of your gas-production problems — "from the wellhead to the consumer!" Contact your National Representative in your area.



One well unit with indirect heater and inlet MONOTUBE® separator.

WRITE FOR BULLETIN 504-A ON GLYCOL DEHYDRATORS.

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TULSA, OKLAHOMA

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See your J & L Man, or write Cabot for engineering specifications or recommendations.

OIL FIELD PUMPING EQUIPMENT

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